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# ABSTRACTS

of recent published material on  
Soil and Water Conservation

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The articles in "ABSTRACTS or recent published material on Soil and Water Conservation" are abstracted by Charles B. Crook in the Soil and Water Conservation Research Division of the Agricultural Research Service.

The ABSTRACTS are issued at irregular intervals. Their purpose is to bring together a summary of current published information about soil and water conservation work. Reprints of abstracted articles are generally not available in the Division. Requests for reprints should be sent to authors or institutions--addresses are appended.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When an entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses follow U.S.D.A. Misc. Pub. 765, July 1958.

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# WATERSHED ENGINEERING

## Watershed Development

Smith, C. E. UPSTREAM FLOOD PREVENTION: OVER-ALL APPROACH IN THE UPPER HOCKING WATERSHED. *Agr. Engin.* 42: 416-419. 1961.

Within the past 25 years, flood prevention work in the United States has grown from concentrated efforts in flood control measures on our major rivers to include measures for preventing floods in our myriads of tributary streams affecting both agricultural and urban properties.

The upstream flood prevention programs have expanded from major emphasis on erosion control by means of various land-treatment practices to include structural measures for stabilizing eroding water courses, retarding flood flows, and improving channel capacities.

Emphasis has changed from federally initiated programs to programs initiated and directed by local communities.

The Upper Hocking pilot watershed in Ohio is a working example of the current approach to upstream flood prevention work. Besides the land treatment work, which has its greatest effect upon reduction of erosion and sediment damages in the watershed, 22 stabilizing structures were included along with eight floodwater-retarding structures to control a total of 52 percent of the drainage area above the city of Lancaster.

The designs for the floodwater-retarding structures were based on the location of the flood damages and types of storms causing the damages. Controls for the agricultural flood damages were based on controlling the more frequent smaller floods. The controls needed to prevent serious damages in Lancaster were based on controlling the more infrequent major floods.

The Upper Hocking watershed effectively demonstrates the soundness of a complete upstream flood-prevention program. The evaluation program included in this watershed provides valuable data concerning rainfall-runoff relationships, gross erosion and sediment transport rates, the effects of land treatment on both runoff and sediment production, and the effects of the structural measures on reducing peak rates of runoff and trapping sediment.

The project demonstrates the opportunities that exist to help develop similar programs in the thousands of other upstream watersheds throughout the nation. In just a little over 6 years since the passage of Public Law 566, known as the Watershed Protection and Flood Prevention Act, almost 1,400 applications have been received by the Soil Conservation Service from local communities for assistance in developing and carrying out similar upstream watershed protection and flood prevention work. About 600 of these have been approved for planning, of which almost 300 are approved for installation of the planned measures.

SCS, USDA, Upper Darby, Pa.

Gray, D. M. INTERRELATIONSHIPS OF WATERSHED CHARACTERISTICS. *J. Geophysical Res.* 66: 1215-1223. 1961.

The application of the principles of dimensional analysis to obtain the relationships between characteristics of the unit hydrograph, and topographic and morphometric properties of a watershed is not possible unless careful consideration is given to the selection of variables. Evidence is presented which shows that, in small watersheds, drainage-area

size A, length of the main stream L, and length to center of area  $L_{ca}$  are highly correlated. In an analysis of several topographic characteristics from a number of small watersheds of different vegetative, soil, lithological, physiographic, and climatic conditions, the following conclusions were reached:

1. The length of the main stream L, drainage-basin area A, and length to the center of area  $L_{ca}$  are highly correlated.
2. The general geometric shape of small watersheds falls between ovoid and pear shape.
3. The slope of the main stream  $S_c$  can be inversely related to the parameters L,  $L_{ca}$ , and A as a simple power equation if consideration is given to regional influence.

Iowa State U. Sci. and Tech., Ames, Iowa.

## Hydrology

Gertel, K. WATER: USES; SUPPLIES; PROJECTIONS--AN INTRODUCTION TO TERMS AND REFERENCE SOURCES. U.S. Dept. Agr., Econ. Res. Serv. (Unnumbered) 56 pp. Sept. 1961.

A compilation to expedite data-gathering phases of research and planning is provided. The compilation was prepared as a reference for economists and others working in the field of water resources. Section I gives definitions of the more common terms found in water resource literature and other terms illustrating important physical relationships. Section II contains the major source materials that report the nationwide systematic inventory of water uses. Section III describes the data program for water supplies, and section IV summarizes projections made of future water uses and supplies.

Each major source of data is described in some detail by type of data, period for which data are available, geographic breakdown, and completeness of coverage. Related references are given.

ERS, USDA, Inform. Div., Washington 25, D.C.

Brakensiek, D. L. ESTIMATING DEPENDABLE ANNUAL STREAMFLOW IN THE UNGLACIATED ALLEGHENY PLATEAU. U.S. Dept. Agr., Agr. Res. Serv., ARS 41-56, 34 pp. 1961.

A procedure is presented for estimating annual streamflow for any level of dependability. The study is limited to the unglaciated Allegheny Plateau area. The data were worked on an annual streamflow amounts, in units of inches over the watershed for watersheds ranging in size from under 100 acres to 400 square miles.

Assuming that annual streamflow amounts are statistical variates, we can write a formal expression (1) for estimating probability-magnitudes as

$$Q_t = \bar{Q} (1 + CV_q K) \quad (1)$$

where for a particular watershed

$Q_t$  = annual streamflow that will not be equalled for a return period T

$\bar{Q}$  = average annual streamflow

$CV_q$  = parameter reflecting inherent variability of annual streamflow

K = standardized deviate for a probability level of  $(1/T)$ ; its value also depends on the statistical distribution of the variates annual streamflow

The application of equation (1) to a particular watershed requires that three items be known or procedures for estimating them be available. The items are: (1) An appropriate statistical distribution for annual streamflow; (2)  $\bar{Q}$ , average annual streamflow; and (3)  $CV_Q$ , inherent variability parameter.

Watershed information for the area is presented in table form and mean annual precipitation maps are presented for the States in the area.

A series of graphs are presented showing the fit of the normal distribution to annual runoff data for various locations in the area.

ARS, USDA, Inform. Div., Washington 25, D.C.

Woo, D., and Brater, E. F. LAMINAR FLOW IN ROUGH RECTANGULAR CHANNELS.  
J. Geophysical Res. 66: 4207-4217. 1961.

The results of an investigation of open channel flow in the laminar and transition ranges are presented. This type of flow is encountered during runoff from rainfall. Values of the friction factor were determined for two roughnesses and for 11 slopes varying from 0.001 to 0.060. It was found that for laminar flow the values departed significantly from the theoretical ones derived for smooth surfaced and that for very rough surfaces the variations depended on the slope. The results for both the laminar and transition ranges are presented graphically to permit comparison with theoretical values and with results obtained by other investigators. These data will prove useful in studies of overland flow and particularly for investigations of soil erosion.

U. Mich., Ann Arbor, Mich.

Harris, B., Sharp, A. L., Gibbs, A. E., and Owen, W. J. AN IMPROVED STATISTICAL MODEL FOR EVALUATING PARAMETERS AFFECTING WATER YIELDS OF RIVER BASINS. J. Geophysical Res. 66: 3319-3328. 1961.

The inference drawn from the ordinary multiple regression approach may be questionable when this method is used to analyze hydrologic data. A statistical model that avoids some of these uncertainties is developed. A Taylor series expansion is suggested to obtain exponential and interaction terms. Orthogonal transformations are used to extract some of the variables for use as predictors. A rule is exhibited for selecting the single most important (based on ability to explain variance in the dependent variable) independent variable, testing its significance, and removing its effects on all remaining variables. A second rule is exhibited for stopping the selection of independent variables when those remaining will not contribute significantly to the further reduction of unexplained variance in the dependent variable. The net result is the selection of a few from many independent variables to use in a "near best" prediction equation. A method is presented for obtaining the multiple regression equation using only the selected variables. The application of the model is illustrated by its use in analyzing data from 763 storms on watershed 3H at the Central Great Plains Experimental Watershed, Hastings, Nebr.

U. Nebr., Lincoln, Nebr.

A simple, rational approach for estimating the water yield of a watershed was developed. The watershed rating obtained by this method is dependent upon measurement and observation of five physical characteristics (climate, soil, land slope, land use, and management and conservation practices). Factors used in determining watershed rating were assigned to these physical characteristics (for southern Iowa conditions) on the basis of experimental data and general observations. The necessity of restricting a given set of factors to a single physiographic region is recognized. A comparison was made, for each of five Iowa watersheds, of water yield estimated from physical characteristics with the measured yield. The estimated median yield from watersheds 525-9,850 acres was within about 12 percent of the measured median yield. This close agreement is an indication of the usefulness of the method as a means of predicting yield from small ungauged watersheds.

SWCRD, ARS, USDA, Lompoc, Calif.

Stall, J. B., and Neill, J. C. A PARTIAL DURATION SERIES FOR LOW-FLOW ANALYSES. *J. Geophysical Res.* 66: 4219-4225. 1961.

A partial series of low-flow events is described, which is particularly useful in the design of an impounding reservoir in Illinois. An important feature of this series is the introduction of the duration of the low flow as a parameter. A number of low-flow series are developed for durations varying from 1 month to 60 months. As compared with the more easily interpreted annual series, one of the principal advantages of this partial series is its suitability for use with low-flow periods longer than 12 months. A recurrence interval is assigned to each low flow in the series, and coordinates are presented for its representation. The flow in terms of runoff from the watershed expressed in inches is plotted on a logarithmic scale versus the recurrence interval for the extreme-value law.

Ill. State Water Survey Div., Urbana, Ill.

Hopkins, C. D., Jr., and Hackett, D. O. AVERAGE ANTECEDENT TEMPERATURES AS A FACTOR IN PREDICTING RUNOFF FROM STORM RAINFALL. *J. Geophysical Res.* 66: 3313-3318. 1961.

Rainfall-runoff relations in New England and New York vary widely from basin to basin in a manner related to average basin latitudes and elevations. Station elevations and latitudes are related to average temperatures. Average monthly and annual temperatures were computed for each basin and average weekly basin temperatures estimated. These weekly temperatures were used to derive an index of average antecedent basin temperatures based on a logarithmic recession. Two rainfall-runoff relationships were derived in which the index of antecedent basin precipitation, the index of average antecedent basin temperatures corresponding to the season of the storm, the average basin temperature, storm rainfall, and storm runoff were used. One of these relations applied to the spring and summer, the other to the fall and winter. Testing showed that a large part of the variation in the rainfall-runoff relationship had been removed. It was concluded that average basin temperatures can be used in computing runoff in New England and New York.

River Forecast Cent., U.S. Weather Bur., Hartford, Conn.

The hydrographic analyses of rainfall-runoff data from storms occurring during the period 1945-1957 were used to estimate soil intake rates and rainfall retention. The intake rates varied from more than 2 inches to less than 0.01 inch per hour, depending mostly upon antecedent soil moisture and duration of the storms. Irrigation generally reduced intake rate unless accompanied by fertility treatments that greatly increased plant growth. Since the dominant factor affecting water intake was soil-moisture content, the effects of plant cover and irrigation on intake may be partly attributed to their effects on stored soil moisture. The mean values for the initial intake rates (for the first 30 minutes) and average intake rates for the 29 storms analyzed varied with antecedent moisture, management practices, and season of the year. The mean values for the final intake rates (at the end of storm) were not significantly different for the different management practices.

SWCRD, ARS, USDA, Columbia, Mo.

Rauzi, F., and Kuhlman, A. R. WATER INTAKE AS AFFECTED BY SOIL AND VEGETATION ON CERTAIN WESTERN SOUTH DAKOTA RANGELANDS. *J. Range Mangt.* 14: 267-271. 1961.

During the summer months of 1957 and 1958, water-intake studies were conducted on instrumented rangeland watersheds in the 10- to 14-inch precipitation belt near Newell, South Dak.

Data from four range sites on four watersheds showed that water-intake rates were correlated with range sites, as mapped by Soil Conservation Service, where the range condition class was comparable. With good range condition class, the water-intake during the first 15-minute period of the 1-hour test was high even on thin or fine-textured soils. The rate of intake declined much more rapidly on such sites in later periods of the test except on thick well-structured clays which maintained a rate comparable to a sandy loam.

The effects of surface conditions such as texture, cracking, and amount of cover are important factors. During prolonged rainfall, subsurface features become important in determining the amount of water absorbed during the storm event.

SWCRD, ARS, USDA, Laramie, Wyo.

Minshall, N. E. EFFECT OF COVER AND SOILS ON SURFACE RUNOFF. *J. Soil and Water Conserv.* 16: 259-264. 1961.

A change in percent of area cultivated has considerable influence on storm runoff from moderately permeable silt loams in Wisconsin but only minor effect on claypan soils, in Illinois. On the claypan soils, a cover change from nearly 100 percent cultivated to 100 percent alfalfa will result in a reduction in storm runoff not exceeding 10 percent. On the moderately permeable silt loams, represented by Fennimore watersheds, a reduction in storm runoff of more than 50 percent may result if cover is changed from 60 to 0 percent cultivated.

From approximately the same average May through October precipitation of 22 inches, the surface runoff from the claypan soils at Edwardsville averaged 3.4 inches per year, or nearly five times as much as for moderately permeable silt loams at Fennimore.

The June 21, 1954, storm on watershed W-2, Fennimore, showed that a good sod mulch is very effective in reducing erosion and surface runoff.

When dry and protected by a good vegetative cover, even the claypan soils will take in precipitation rather rapidly until the surface layer becomes saturated, after that a high percentage of any additional precipitation will run off.

The effects of cover on runoff are quite pronounced for small storms but of only minor importance in storms causing major floods.

SWCRD, ARS, USDA, Madison, Wisc.

Dortignac, E. J., and Love, L. D. INFILTRATION STUDIES ON PONDEROSA PINE RANGES OF COLORADO. Rocky Mountain Forest and Range Expt. Sta., Sta. Paper 59, 34 pp. 1961.

Ponderosa pine (Pinus ponderosa Lawson) ranges are characteristic of much of the Colorado mountains east of the Continental Divide. These timbered ranges occupy, at elevations from 6,000 to 9,000 feet, ridges, mountain slopes, foothills, steep rocky canyons, and mountain valleys. On more level areas they are intermingled with open grassland parks. Soils are variable and are developed from several parent rocks; the majority are derived from granites which disintegrate readily, producing unstable soils that erode and wash away rapidly when exposed.

Three broad vegetation classes are recognizable: (1) Stands of dense timber, mainly ponderosa pine, with closed canopies and a ground cover of tree litter; (2) timbered grasslands, an open forest of ponderosa pine with a ground cover of herbaceous vegetation and pine litter; and (3) open grassland parks supporting herbaceous vegetation.

Results of infiltrometer studies designed to evaluate the relationships between soil, vegetation, and infiltration are presented. These studies were conducted at the Manitou Experimental Forest from 1941 through 1954, and on the Elk Ridge Allotment in the Roosevelt National Forest in 1950.

The following conclusions were made by the authors:

1. Infiltration varied with cover type on ponderosa pine ranges. These rates for 1946 and 1952 averaged: Pine-litter, 2.37; Pine-grass, 1.94; and grassland, 1.50 inches per hour.
2. Weight of dead organic material and the amount of noncapillary pores in the surface soil were the most important measured factors influencing infiltration rates of granitic alluvium soils occurring in the Manitou pastures.
3. Providing protection from cattle grazing resulted in an increase in infiltration rates from those measured at the start of the experiment in 1941. Rather rapid recovery of infiltration rates was observed on pine-grass, especially in the first 6 years of protection. In the grassland, recovery of infiltration rates continued through 1954, or 13 years after the start of the experiment.
4. Infiltration rates in grassland and pine-grass can be estimated by measuring the quantity of dead organic material and noncapillary pores in the surface soil. In the Manitou pastures, 35 percent of the variation in infiltration rates (Y) between individual infiltrometer plots was accounted for by the two factors, grams of dead organic material per plot ( $X_1$ ), and percent noncapillary pores ( $X_2$ ). This regression equation:

$$Y = 0.00288 (X_1) + 0.0374 (X_2) + 0.43$$

best expressed this relationship. The standard error of regression is  $\pm 0.62$  inch per hour.

5. There is a significant relationship between infiltration rates on dry and wet surface soil. The estimated infiltration rate on dry soil (Y) and the infiltration rate on prewetted soils (X) can be expressed as follows:

$$\begin{array}{ll} \text{for pine-litter} & Y = 0.85X + 0.46 \\ \text{for pine-grass} & Y = 0.71X + 0.75 \\ \text{for grassland} & Y = 1.00X + 0.41 \end{array}$$

Standard errors for the regression equations are  $\pm 0.45$  (pine-grass); and  $\pm 0.36$  (grassland) in inch per hour.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Bender, D. L., and Roberson, J. A. THE USE OF DIMENSIONLESS UNIT HYDROGRAPH TO DERIVE UNIT HYDROGRAPHS FOR SOME PACIFIC NORTHWEST BASINS. J. Geophysical Res. 66: 521-527. 1961.

A simple trial-and-error method of developing unit hydrographs from long-period storms by making use of a general dimensionless unit hydrograph is presented. The development of a general dimensionless unit hydrograph is based on approximately 20 unit hydrographs from the Willamette Valley in Oregon. A method of using the general dimensionless unit hydrograph to derive unit hydrographs from long-period storms and the drainage area of the basin is also presented. The method consists in first converting the dimensionless unit hydrograph into a unit hydrograph by using the drainage area of the basin and assuming a time base. This unit hydrograph is then applied to a long-period storm to produce a storm hydrograph. If they compare favorably, the unit hydrograph used is the unit hydrograph for the basin. If they do not compare favorably, another unit hydrograph is used, assuming a new time base. This process is repeated until a favorable comparison is obtained. The method is adaptable to the electronic computer and has been successfully tested on the IBM 650 computer.

Wash. State U., Pullman, Wash.

## Geology

Argyropoulos, P. A. WATER SURFACE PROFILES IN IRREGULAR NATURAL STREAMS. J. Hydraul. Div., ASCE 87(HY 4): 1-10. July 1961.

A relatively simple and practical method is proposed for the computation of water surface profiles in natural streams or reservoirs. It is a safe and specially advantageous method when several backwater profiles must be determined in the channel.

The velocity head corrections have been taken into account. The effect of bend losses, bridge-pier losses, and losses owing to change in shape of the cross section can be included when necessary. The method is based on the assumption that the velocity of flow is not uniformly distributed over the area of any cross section.

Civil Engin., Specialist in Sci. Res., Athens, Greece.

Tison, L. J. LOCAL SCOUR IN RIVERS. J. Geophysical Res. 66: 4227-4232. 1961.

The scour in rivers is influenced not only by water velocities but also by the curvature of streamlines. An obstacle with an arbitrary shape placed in a stream produces curvatures,

which are the origin of a scour and which have an intensity expressed in terms of the velocity at the surface, the velocity in the neighborhood of the bottom, and the radius of curvature of the streamline. Integrals are taken along a line tangent at each point to the principal normal of the streamlines. Some applications of the relationship are presented.

U. Ghent, Braamstraat 61, Gentbrugge, Belgium.

Borland, W. M. SEDIMENT TRANSPORT OF GLACIER-FED STREAMS IN ALASKA.  
J. Geophysical Res. 66: 3347-3350. 1961.

An empirical parameter is developed in terms of the glacier area, total drainage area, and length of watercourse. A graphical relationship is presented between the parameter, expressed as a fraction, and the sediment yield rate. Hydrologic records with particular emphasis on sediment data collected for glacier-fed streams provided the basis for the analysis leading to the development of the empirical parameter.

Bur. Reclam., U.S. Dept. Interior, Denver, Colo.

Andre, J. E., and Anderson, H. W. VARIATION OF SOIL ERODIBILITY WITH GEOLOGY, GEOGRAPHIC ZONE, ELEVATION, AND VEGETATION TYPE IN NORTHERN CALIFORNIA WILDLANDS. J. Geophysical Res. 66: 3351-3358. 1961.

Samples of the surface 6 inches of mineral soil were taken at 168 places in northern California and analyzed for the physical characteristics which index erodibility of the soil. The samples were selected in the major soil-geologic types of California, under standard conditions of slope (west, 20 percent), at 1000-foot intervals of elevation (1,000 to 4,000 feet), by vegetation types (forest, brush, and grass), and in three separate zones (North Coast, Central Coast, and Sierra). A multiple regression analysis related the 'surface-aggregation' and 'dispersion' ratios, as the indexes of erodibility, to geologic type, vegetation type, zone, and elevation and to their interactions. The surface-aggregation ratio was somewhat more significantly related to soil erodibility than was the dispersion ratio. Soil developed from acid igneous rock was about 2-1/2 times as erodible as soil developed on basalt. Erodibility was highest for soils under brush, next under trees, and least under grass. No clear-cut relation of erodibility to elevation was found. The interaction of zone and geologic rock type showed significant variation in erodibility. The prediction equation explains 52 percent of the variability in erodibility in soils. By combining predicted erodibility from this equation with chemical base status, for a sample of 20 of the soils, the explained variance was improved. Application of these relationships in studies of sedimentation from watersheds is illustrated.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Walton, W. C., and Walker, W. H. EVALUATING WELLS AND AQUIFERS BY ANALYTICAL METHODS. J. Geophysical Res. 66: 3359-3370. 1961.

The practical application of available analytical methods to ground-water resource management problems in Illinois is described. The actual ground-water condition is simulated by a model aquifer having straight-line boundaries, an effective width, length, and thickness, and sometimes a confining bed with an effective thickness. The hydraulic prop-

erties of the model aquifer and its confining bed, the image-well theory, and ground-water formulas are used to construct a mathematical model which provides a means of evaluating the performance of wells and aquifers. Records of past pumpage and water levels establish the validity of this mechanism as a model of the response of an aquifer to heavy pumping.

For demonstration of the applicability of model aquifers and mathematical models, case histories of ground-water development in the Chicago region in northeastern Illinois and the Arcola, Taylorville, Tallula, Assumption, and Pekin areas in central Illinois are described. The model aquifers for the study areas range from a semi-infinite rectilinear strip of sandstones and dolomites 84 miles wide and 1,000 feet thick to a semi-infinite rectilinear strip of sand and gravel 300 feet wide and 3.5 feet thick. Practical sustained yields of the aquifers range from 46 million gallons per day to 16,000 gallons per day.

III. State Water Survey, Urbana, Ill.

Luszynski, N. J. HEAD AND FLOW OF GROUND WATER OF VARIABLE DENSITY.

J. Geophysical Res. 66: 4247-4256, 1961.

Fresh-water and environmental-water heads are shown to be useful in studying movement of ground water of variable density, such as in a system of fresh, diffused, and salt water. Fresh-water head at a given point in ground water of variable density is defined as the water level in a well filled with fresh water from that point to a level high enough to balance the existing pressure at the point. Fresh-water heads define hydraulic gradients along a horizontal. An environmental-water head at a given point in ground water of variable density is defined as a fresh-water head reduced by an amount corresponding to the difference of salt mass in fresh water and that in the environmental water between that point and the top of the zone of saturation. Environmental-water heads define hydraulic gradients along a vertical. Vertical and horizontal components of velocity in an anisotropic system with ground water of variable density are computed from hydraulic gradients defined by environmental-water and fresh-water heads, respectively, and from appropriate components of the permeability tensor. Equations for the component velocities are based on a particular generalized form of the Darcy equation. An equation showing a relation between the head observed in fresh water overlying diffused water and the elevation of the contact between fresh water and diffused water is given. The equation is based on the concept of environmental head. It is found to be a suitable basis for defining the specific limitations of the Ghyben-Hersberg and the Hubbert equations when they are used for fresh-diffused-salt water environments.

U.S. Geol. Survey., Mineola, Long Island, N.Y.

Benz, L. C., Mickelson, R. H., Sandoval, F. M., and Carlson, C. W. GROUND-WATER INVESTIGATIONS IN A SALINE AREA OF THE RED RIVER VALLEY, NORTH DAKOTA. J. Geophysical Res. 66: 2435-2443. 1961.

In a ground water study in a saline area of the Red River Valley, N. Dak., the authors concluded:

1. The salt-affected area studied has a high water table, poor drainage conditions, and saline artesian waters.

2. Rainfall was a major contributor to high water tables. Water tables rose 3 to 7 feet during the growing season, when 65 to 70 percent of the yearly precipitation normally occurs. Maximum rises and near-ground-surface fluctuations usually occurred during the first half of the growing season.
3. The water-table depth followed a seasonal pattern. During the winter it dropped; in the spring a sharp rise occurred, probably due primarily to frost leaving the soil and downward percolation of snow-melt. Summer fluctuations occurred and were due chiefly to percolating rain water. If autumn precipitation was normal the water table slowly receded.
4. Flat topography and poor surface and interal drainage contribute to the high water tables. Runoff occurs principally in the spring, when soils are frozen, and during high-intensity rains. Highly saline areas were usually areas having high water tables. Salt concentrations of the shallow waters are probably due to evapotranspiration forces.
5. The similar chemical composition of shallow water in glacial drift and deeper artesian waters indicates that waters from the Dakota sandstone are primary sources of salts. Shallow ground waters from lacustrine sediments had a different chemical composition than the artesian waters, probably owing to the tendency of the lacustrine sediments to fix or filter out boron and contribute magnesium.
6. Upward flow gradients indicated upward water movement in the soil profile. Amounts of water fed into the area by artesian sources are sufficient to contribute salts and keep the soil substratum well saturated with water.
7. Concentrations of salt occur in both glacial drift and lacustrine sediment ground waters. The largest acreage is in the latter. Glacial drift lies at a higher elevation, and salinity in the drift may be due to nearness of the sand and gravel lenses in the drift to the ground surface. In the lacustrine areas, salts are probably due to waters being fed into these areas by the higher-elevation sand and gravel lenses in the drift and/or by seepage upward through the fine sediments.

SWCRD, ARS, USDA, Grand Forks, N. Dak.

### Engineering Design

Karaki, S. S., Gray, E. E., and Collins, J. DUAL CHANNEL STREAM MONITOR. J. Hydraul. Div., ASCE 87(HY 6): 1-16. Nov. 1961.

The dual channel stream monitor is an ultrasonic instrument developed to monitor water surface and stream bed profiles simultaneously under dynamic conditions in an alluvial channel. The instrument was developed primarily as a laboratory tool to aid hydraulic research.

The stream monitor is a light-weight, portable, fully transistorized instrument that uses the echo ranging principle to determine distances to reflecting surfaces. Two piezoelectric transducers are used. Power requirement is 15 w, and the instrument will operate with either 115-v, 60-cycle AC or a self-contained battery pack.

The range of the instrument is from 0 ft. to 10 ft. of flow depth with a stepdown scale at shallow depths to provide for greater accuracy in measurement. The readout is presented on a dual channel strip-chart recorder that registers water surface and stream bed profiles separately.

The dual channel stream monitor is a satisfactory instrument to monitor water surface and stream bed profiles in an alluvial channel for purposes of hydraulic research. When operated with a rectilinear recording milliammeter, the total instrument complex has

an accuracy of  $\pm 0.05$  ft. on the 5-ft. scale and  $\pm 0.02$  ft. on the 1-ft. scale. The accuracy of the instrument complex is restricted by the accuracy of the recorder. It is possible to improve the accuracy by using either a more sensitive recorder or an oscilloscope.

Under normal stream flow velocities excellent results are achieved by the dual channel stream monitor.

Colo. State U., Fort Collins, Colo.

Whipkey, R. Z. PLYWOOD CUTOFF WALLS FOR TEMPORARY WEIRS. Central States Forest Expt. Sta., Sta. Note 150, 2 pp. 1961.

Plywood cutoff walls can be used in place of concrete where the trouble and expense of building a permanent stream-gaging structure are not warranted and where there is little sediment or debris. Plywood cutoff walls were used successfully for 18 months on two 20-acre forested watersheds in eastern Ohio.

The plywood cutoff walls are described and illustrated.

Experience shows that the 90-degree, sharp-crested blade on the plywood assures sensitive, low-flow measurements. The maximum flow has been 38.51 cubic feet per second per square mile (0.79-foot stage) and the minimum flow 0.005 cubic foot per second per square mile (0.02-foot stage). Volumetric measurements of discharge were made down to 0.04-foot stage and these have checked closely with the theoretical values given by the equation:  $Q = 2.5 H^{2.47}$  where  $Q$  is discharge in cubic feet per second and  $H$  is stage in feet. This implies similarity in the friction coefficient between plywood cutoff wall and that of the material used in deriving the original weir equation.

Central State Forest Expt. Sta. FS, USDA, Columbus, Ohio.

Bogardi, J. SOME ASPECTS OF THE APPLICATION OF THE THEORY OF SEDIMENT TRANSPORTATION TO ENGINEERING PROBLEMS. J. Geophysical Res. 66: 3337-3346. 1961.

Sediment transportation in natural streams is to an appreciable extent influenced by the hydrological conditions of the watercourse. Widely different hydrological conditions are encountered at various watercourses. Owing to these very differences, the theoretical laws governing sediment transportation that have been derived by considerations of hydrodynamics, or established on the basis of laboratory experiments carried out under more-or-less ideal conditions, can be used with the greatest conservatism only. Several examples of the effect of hydrological conditions on the sediment transporting capacity, on the relationship between discharge and sediment concentration, and on the correlation between the particle diameter and mean velocity are listed.

Hydraul. Lab., Res. Inst. for Water Resources Devlpmt. Budapest, Hungary.

### Ground Water Recharge

Baumann, P. THEORETICAL AND PRACTICAL ASPECTS OF WELL RECHARGE. J. Hydraul. Div., ASCE 87(HY 6): 155-170. Nov. 1961.

Theoretical and practical aspects of recharge through wells were studied and the following conclusions were drawn for fresh water aquifers:

1. Structurally recharge wells differ little if any from gravel jacketed water wells, but there is a fundamental difference in their hydraulic idiosyncrasies. Recharge wells cannot be treated simply as water wells in reverse.

2. A water well in an open aquifer is always governed by atmospheric pressure. A recharge well in one and the same aquifer can be operated under any arbitrary pressure so long as the flow from the well remains laminar. If chlorination of recharge water is necessary to prevent bacterial clogging of the soil or for reasons of sanitation, all materials installed in the well should be immune to chlorine attack.
3. The spacing of wells in open or confined aquifers for recharge only should be not less than  $2 W$ , whereas for the control of undesirable groundwater such as sea-water, the well spacing should be  $<W$ .  $W$  is defined as the given rate of recharge over transmissibility per unit width of aquifer. If a fresh water barrier is used for the control of sea-water, recharge of the aquifer is a beneficial byproduct.
4. To prevent landward flow of the intruded sea-water or waste of recharge water to the ocean, the seaward flow of recharge water must be curtailed. The practical implication in the accomplishment may rest with the reduction in the number and size of both of perforations in the seaward one-half of the recharge well casing. This postulate could only be established through test.
5. A fresh water barrier will give rise to a saline wave if located within the intruded sea-water wedge. If feasible such a barrier should be located landward from the sea-water wedge, so as to prevent the initiation of a saline wave. Without a barrier there will not only be a temporary saline wave but an uninhibited invasion of sea-water resulting in eventually putting all water wells in its path out of commission.
6. Fundamental in regard to the fresh water head required to stem saline water intrusion is the Ghijben-Herzberg principle. To apply it, the depth to the impervious sole of an aquifer must be known. As this depth cannot always be precisely established, a safety factor should be applied.

Construction Engin., Sierra Madre, Calif.

Schiff, L. EFFECT OF FILTERING ON MODEL RECHARGE WELLS. *J. Irrig. and Drain. Div., ASCE 87(IR 4): 55-63. Dec. 1961.*

Maintenance of injection rates is an important consideration in the use of shafts and wells for recharge or water disposal. In one experiment covering 75 days, water rose about four times higher in wells receiving unfiltered water than in wells receiving the same flow of filtered water. This was due to clogging by suspended solids carried into the wells by the unfiltered water. Filtering through 0.2 ft. of filter material reduced the suspended load in the water from about 20 p.p.m. to 1 p.p.m. This occurred in experiments in which the water was ponded on the filter material and in experiments in which water was made to flow over the filter material.

River water flowing over filter material passed through the filter at more than twice the rate than when ponded on the filter. Surfaces over which water flowed appeared clean for velocities of 1/2 f.p.s. However, fines were carried into the filters as indicated by a drop in percolation rate and by losses in hydraulic head. Raking the filters to a depth of about 1/2 in. caused deposited fines to go into suspension and be carried away by the flowing water. By this simple process, good recovery occurred in the infiltration rate of filters, and thus, into the wells.

This approach envisions potential use of shafts or shallow wells with overlying filter materials strategically spaced in waterways. Maintenance would be simplified by the ability of flowing water to hold certain soil particles in suspension and to pick up particles on disruption of the upper portion of the filter material.

SWCRD, ARS, USDA, Fresno, Calif.

Clyma, W., and Jensen, M. E. FLOCCULENT USED TO REMOVE SEDIMENTS FROM PLAYA LAKE WATER USED FOR GROUNDWATER RECHARGE. Tex. Agr. Expt. Sta. Prog. Rpt. 2144, 7 pp. 1960.

By using a commercial flocculent, Separan AP-30, the amount of silt plus clay entering a recharge well in a 24-hour period was reduced 49 percent. The quantity of silt plus clay removed from the well during the 1-hour pumping cycle following recharge was 2.4 percent of the amount that entered the well. The combination of the flocculent and pumping cycle resulted in 50.2 percent less sediments in the well, compared with 7 to 10 percent removed using the pumping cycle alone.

SWCRD, ARS, USDA, and Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Clyma, W., and Broadhurst, W. L. CLARIFICATION OF PLAYA LAKE WATER BY AERIAL APPLICATION OF A FLOCCULATING AGENT. Tex. Agr. Expt. Sta. Prog. Rpt. 2168, 6 pp. 1961.

Dusting playa lakes with a nontoxic, synthetic, organic flocculent removed 43 to 93 percent of the silt and clay in the water. The flocculent was applied to the lake surface with a crop-dusting plane. Wave action, caused by wind, mixed the flocculation, and settlement of the sediments resulted. When clarified the Lake water is used for ground water recharge for irrigation.

SWCRD, ARS, USDA, and Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Meyboom, P. ESTIMATING GROUND WATER RECHARGE FROM STREAM HYDROGRAPHS. J. Geophysical Res. 66: 1203-1214. 1961.

It is possible to separate graphically the base flow on stream hydrographs by plotting the logarithm of the discharge against time. Total potential ground-water discharge ( $Q_{tp}$ ) at the beginning of any given base-flow recession is

$$Q_{tp} = K_1 K_2 / 2.3$$

where  $K_1$  = ground-water discharge at the beginning of the base-flow recession ( $t_0$ ), in acre feet per day;  $K_2$  = time increment corresponding to one log cycle change in  $Q$ , in days.

The difference between the actual amount of ground-water discharge at the end of the base-flow recession and the total potential ground-water discharge at the beginning of the same recession is called 'remaining potential ground-water discharge.' The difference between the total potential ground-water discharge at the beginning of any given base-flow recession and the remaining potential ground-water discharge at the end of the preceding base-flow recession is a measure of ground-water recharge.

This method of hydrograph analysis is believed to be a potentially useful method of evaluating a regional ground-water balance. It gives quantitative information regarding the entities that make up the basic hydrologic equation. The method is of particular value for areas where stream-gaging records and meteorological data have been collected but where a detailed hydrogeological survey would be uneconomic or otherwise impossible.

The work suggests that along the eastern edge of the Canadian foothills and Rocky Mountains, where Cretaceous shales and sandstones underlie glacial drift, bedrock and aquifers are a very limited source of ground water, owing to the extremely low rate of natural ground-water recharge to these aquifers. Ground water released from bank storage is an important contributor to dry-weather stream flow in this area; consequently, aquifers from which large quantities of water can safely be withdrawn are to be expected only in alluvial deposits of sufficient thickness along the present rivers.

Res. Council Alberta, Edmonton, Alberta, Canada.

## WATER MANAGEMENT

### Irrigation

Soil Conservation Service. WATER CONSERVATION IN IRRIGATION AGRICULTURE. U.S. Dept. Agr., Soil Con. Serv. SCS-TP-141, 14 pp. 1961.

In nearly any community where a major part of the water supply is used for irrigation, future expansion in water needs might be met, at least in part, through more efficient handling and use of irrigation water. In many instances, the land now being irrigated could be adequately served with half the water now being used.

Conservation methods of applying water on farms, coupled with efficient storage and transmission from the source, can reduce wastage and free large quantities of water for extending the irrigated acreage for at least the next 20 years, if the savings could be made available at the right places. Experience of many individual farmers in soil conservation districts shows that it is physically possible to attain an even higher degree of efficiency with methods now available.

SCS, USDA, Inform. Div., Washington 25, D.C.

Musick, J. T., and Grimes, D. W. WATER MANAGEMENT AND CONSUMPTIVE USE OF IRRIGATED GRAIN SORGHUM IN WESTERN KANSAS. Kans. Agr. Expt. Sta. Tech. B. 113, 20 pp. 1961.

In a study of water management and consumptive use of irrigated grain sorghum in western Kansas, the authors made the following conclusions:

1. Maximum yield occurred for the control treatment which received four irrigations as follows: preplanting, 10- to 14-inch height, boot stage, and milk stage of grain. Irrigation for maximum yield decreased both efficiency of water use and applied irrigation water.
2. Maximum efficiency of water use occurred when seasonal use was 22 inches or less. Water management for maximum efficiency varied from preplanting irrigation only to three irrigations where the last irrigation was applied at boot to heading stage.
3. Moderate to severe moisture stress decreased yield and efficiency of water use. This decrease accelerated greatly as stress severity increased.
4. Soil moisture when measured in the top 4 feet was most closely related to reduction in yield from limited available soil moisture and moisture stress. As soil moisture

approached the permanent wilting percentage, the decrease in grain yield accelerated greatly.

5. Significant reductions in yield occurred when the available soil moisture in the top 4 feet depleted below 30 percent, approaching boot through dough stages of development. When analyzed for successive depths, significant reductions in yield occurred when the 0 to 1-foot depth depleted below 25 percent available soil moisture and the 0 to 6-foot depth depleted below 35 percent.
6. The seasonal consumptive use-yield relationship was curvilinear between the water use range of 15 to 24 inches. The increase in yield with increased seasonal consumptive use tapered off between 21 and 24 inches.
7. Yield from preplanting irrigation only to 6 feet depth averaged 76.6 bushels per acre compared with 116.3 bushels per acre for maximum yield treatment and 3.18 bushels per acre from dryland fallow on a separate experimental site.
8. The average increase in yield per irrigation for four successive irrigations was 41.1, 28.8, 10.7, and 3.3 bushels per acre, 1955-59. The 41.1 bushels per acre is the approximate increase in yield of preplanting irrigation over dryland fallow.
9. Limited irrigation will increase the efficiency of using a limited irrigation water supply for grain production. Efficient water management may include some acreage receiving off-season or preplanting irrigation only and grown under dryland management practices.
10. The peak daily rate of water use varied between irrigation treatments and years. It averaged 0.29 inch per day for the control treatment and occurred at boot through heading stage of growth.
11. Monthly coefficients, "k", for the Blaney-Criddle consumptive use formula were 0.61, 0.94, 1.08, 0.87, and 0.56 for late June, July, August, September, and to mid-October, respectively. Seasonal coefficient, "K", averaged 0.90 in 1957-59.
12. Irrigation water requirements vary with initial soil moisture storage, irrigation efficiency, consumptive use, and seasonal precipitation.

SWCRD, ARS, USDA, and Kans. State U., Agr. Expt. Sta., Manhattan, Kans.

Pengra, R. F. USING CLIMATIC WATER BALANCE TO DETERMINE IRRIGATION NEEDS IN SOUTH DAKOTA. S. Dak. Agr. Expt. Sta. B. 496, 24 pp. 1961.

Estimates of average soil moisture and the amount of irrigation water required to maintain a definite soil moisture level are of particular value for planning irrigation projects for large areas or for individual farms.

Information that would be of value to technicians in planning irrigation for the different areas of South Dakota was developed. The method can also be used to develop irrigation needs for individual farms.

The use of historical data was necessary to determine needs during past years as an estimate of probable future needs. The study points out the portion of the growing season during which irrigation was needed, the frequency of irrigation, and the total amount of irrigation water that would have been needed to maintain soil moisture above the drought point during previous years. Weather data were used from 1930 to 1946 in order to include years both below as well as some above normal or average precipitation.

The stations of Brookings, Redfield, and Newell were selected to represent the eastern, central, and western portions of the State.

Tables and graphs.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

There are few localities in America where conservation of water is practiced more intensively than in Arkansas County, Ark., an area having normal rainfall of about 55 inches annually.

There was a time, when farmers depended principally upon ground water to irrigate rice and other crops. In recent years the ground water table has dropped and its alkalinity has increased. Technicians foresee a time when ground water will neither be suitable for watering crops, nor available in sufficient quantity to meet landowners' needs. A program has developed to capture and utilize fully the region's naturally abundant rainfall. The program is quite simple. Each farm is equipped with two water systems: One to collect and store all runoff, the other to distribute the stored water to the various fields as it is needed.

Already, more than 50 percent of the water used to irrigate the county's 200,000 acres of improved land is surface water, and the program continues to expand. The Arkansas County SCD has a goal-to irrigate every acre in its district, and to do as much of it as possible with runoff water. If its progress continues, that goal will be attained.

Land and Water Contract., P.O. Box 2268, Montgomery, Ala.

Thompson, G. A., Curry, R. B., and Thornton, J. F. COMPARISON OF IRRIGATION SYSTEMS FOR ALLUVIAL SOILS. Mo. Agr. Expt. Sta. Res. B. 758, 8 pp. 1960.

A comparison of sprinkler and surface methods of application of irrigation water on corn plots was made at the Soil Conservation Service, Plant Materials Center, Elsberry, Mo., from 1955-58. Results were as follows: (1) A mean depth of 1.96 inches of water per irrigation was placed in the root zone by the furrow method as compared with 2.22 inches of water placed there by the sprinkler method. The difference approaches significance (probability level 0.07). The intake rate under sprinkler irrigation averaged 0.30 inches per hour, under furrow irrigation the intake rate was 0.23 inches per hour. (2) Mean water application efficiencies as indicated by the data were 68 percent for the sprinkler method and 62 percent for the furrow method. And (3) both methods of irrigation gave significant increases in yield. (Sprinkler, +13.30 probability level 0.02 furrow, +11.56, probability level 0.03 over non-irrigated corn.) The sprinkler method gave slightly higher (+1.74 probability level 0.71) but not significantly higher yields than the furrow method. In similar areas, the choice between sprinkler or furrow irrigation would seem to be based mostly on equipment and operational costs.

SWCRD, ARS, USDA, and U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

Bertrand, A. R., and Parr, J. F. DESIGN AND OPERATION OF THE PURDUE SPRINKLING INFILTROMETER. Ind. Agr. Expt. Sta. Res. B. 723, 15 pp. 1961.

Water infiltration data for different soils are essential for good land use planning. However, most water management practices are based upon inadequate knowledge of infiltration because there is no widely accepted, practical method to determine the relative infiltration rates of soils.

The primary objective of this research was to develop and evaluate an acceptable instrument for field measurement of infiltration. The design and operation of the Purdue Sprinkling Infiltrometer is described and illustrated.

Tables, photographs, and drawings.

SWCRD, ARS, USDA, and Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Bergstrom, W. WEED SEED SCREENS: FOR IRRIGATION SYSTEMS. Pacific Northwest Coop. P. PNWB. 43, 8 pp. 1961.

Screening water as it enters an irrigated farm is a good management practice. It saves both labor and dollars. It helps keep the system trash free and lessens weed problems.

Weed seeds travel by water and will germinate after being in water for months or even years. Actual samples of screenings have contained up to 4-1/2 percent weed seed by weight. Over 40 different varieties of weed seed have been found.

It's far easier to sweep seeds off a screen and burn them than it is to control growing plants.

Some advantages of screening water are: (1) Keeps supply ditches weed and trash free; (2) cuts down the spread of weed seed on crop land; (3) prevents clogging in sprinkler systems; (4) prevents clogging of siphons, spiles, and pipeline valves; and (5) delays the need for chemical weed control on new land.

A good workable weed seed screening device is an essential part of the weed control program on irrigated farms. The type of screen to use depends on whether or not there's fall where the water enters the farm.

Various types of screens are described and illustrated.

Wash. State U. Ext. Serv., Pullman, Wash.

Lauritzen, C. W., LINING IRRIGATION LATERALS AND FARM DITCHES. U.S. Dept. Agr., Agr. Inform. B. 242, 11 pp. 1961.

A technical discussion on lining irrigation laterals and farm ditches are presented.

The following items are discussed: (1) Preparation of channels for lining; (2) lining materials-various types concrete, asphalt and asphalt-coated jute linings; and (3) costs of the various linings.

ARS, USDA, Inform. Div., Washington 25, D.C.

Walker, P., and Lillard, J. H. LAND FORMING IN THE SOUTHEAST. J. Soil and Water Conserv. 16: 166-169. 1961.

In summarizing the current information on land forming in the Southeast, it was concluded that: (1) The practice of land forming will become increasingly important as more knowledge and experience in its application to specific conditions become available. (2) The studies in Virginia on two widely different soil and topographic conditions indicate that on soils with poor internal drainage it is desirable to form slopes of about 0.15 percent while on the better drained soils, it is probable that a 0.10 percent slope will provide adequate surface drainage. (3) Under many soil conditions where ridged-row cultivation is to be

practiced, forming to a continuous grade only in the direction of crop rows will provide satisfactory surface drainage at minimum forming costs. Where the natural land slopes are very low (less than 0.10 percent), it may be preferable to completely form the land in both directions. (4) Forming costs will range from a low of about \$35 per acre for the one direction forming with ridged-row cultivation to \$65 per acre where complete forming in both directions is performed without cutting for grade above the natural land slope. On near-zero slopes where extensive cutting to obtain the desired grade is necessary, this cost may be doubled. The cost is affected not only by the topographic features of the land but also by the size and shape of the area. And (5) soil mixing and compaction resulting from forming operations often have initial adverse effects upon crop yields and additional operations are required to overcome them. In all cases, it is desirable to practice periodic smoothing to maintain formed grades.

SWCRD, ARS, USDA, Blacksburg, Va.

Davis, S. UNIFICATION OF PARSHALL FLUME DATA. *J. Irrig. and Drain. Div., ASCE* 87(IR 4): 13-26. Dec. 1961.

The Parshall critical depth flume has been used extensively in the Western United States and other parts of the world since about 1925 and is accepted as a standard measuring device in open channel irrigation.

The original design, which was somewhat empirical, has been maintained until now; also the results have been presented as a number of empirical formulae covering widths ranging from 1 in. to 50 ft. For these reasons, engineers have hesitated to use sizes of flumes other than those specified and have felt that great care must be taken to build the flumes according to the dimensions given.

In this paper, dimensional methods have been used to develop a semi-theoretical equation relating flow and depth for all flumes from 1 in. to 50 ft. Excellent agreement between this equation and all published data is found. This will permit using flumes of non-standard sizes and will broaden the field of application for this type of measuring device.

Israel Inst. Tech., Haifa, Israel.

Edminster, T. W., and Staff, C. E. PLASTICS IN SOIL AND WATER CONSERVATION. *Agr. Engin.* 42: 182-185, 248-249. 1961.

The possibilities for utilizing plastics to aid engineering progress in soil and water conservation are limitless. The following practices are discussed and reviewed briefly in the two articles: plastic pipe; irrigation tubing; mole channel liners; rice levees; irrigation borders; irrigation dams and systems; canal and ditch lining; pond liners; concentrating runoff; and reduction of evaporation by use of plastic mulches. Each application has been the result of an engineer comparing the requirements of a job with the "properties and capabilities of a material." Imaginative thinking, well-planned tests, and careful evaluation of the available materials provide the means of finding new, effective, efficient, and economical solutions to soil and water conservation engineering problems.

SWCRD, ARS, USDA, Beltsville, Md.

Jacobs, H. S., Naddih, B. I., and Dixon, R. M. CORRELATIONS BETWEEN CONSTITUENTS IN IRRIGATION WATERS AND IRRIGATED SOILS IN KANSAS. *Soil Sci. Soc. Amer. Proc.* 25: 404-407. 1961.

Soil and water from 26 sites from north-central and southwestern Kansas were studied to determine if knowledge of the chemical composition of irrigation water could be used to predict salt and Na accumulation in soil. Samples were collected in the summer of 1958 and 1959.

Mean exchangeable Na percentage in irrigated soils can be predicted with reasonable accuracy from constituents in irrigation water using Gapon's equation, soluble Na percentage, or the Na adsorption ratio as the basis for estimation. Exchangeable Na percentage can be estimated with an accuracy of  $\pm 1.8$  at the 0.90 probability level for 25 out of the 26 soils.

Correlation between conductivity of soil saturation extracts and that of irrigation water was 0.98 when observations were restricted to soils that: (1) Increased in total salt content upon irrigation; and (2) in which conductivity of the saturation extract exceeded that of irrigation water. Maximum irrigation water electrical conductivity used on such soils was 2.28 mmho. per cm. For this value, soil saturation extract electrical conductivity could be predicted with an accuracy of  $\pm 0.54$  mmhos. per cm. at 0.90 probability level.

Electrical conductivity of soil saturation extracts varied from 0.4 to 4.7 mmho. per cm. at 25°C. Mean exchangeable Na percentage ranged from 0.1 to 6.2. Irrigation water ranged in conductivity from 0.3 to 4.9 mmhos. per cm. at 25°C.

Kans. State U., Manhattan, Kans.

Lunin, J., Gallatin, M. H., and Batchelder, A. R. EFFECT OF SALINE WATER ON THE GROWTH AND CHEMICAL COMPOSITION OF BEANS: II. INFLUENCE OF SOIL ACIDITY. *Soil Sci. Soc. Amer. Proc.* 25: 372-376. 1961.

Two greenhouse experiments were conducted to determine the relationship between soil acidity and salinity on the growth and chemical composition of snap beans.

One experiment was carried out on a Sassafras fsl soil limed to give three pH levels. During the growth of the crop, four 1-inch irrigations of dilute synthetic sea water having EC values of 2, 4, and 8 mmhos./cm. were applied as well as demineralized water. Growth depression with increasing salinity was greatest on the most acid soil. Increasing salinity depressed pH values and increased the availability of manganese in the soil and its uptake by the plant. Liming had the reverse effect.

The second experiment was conducted on the Portsmouth sicl soil limed to give four levels of base saturation. Increasing salinity decreased soil pH but did not increase the availability of Fe, Al, or Mn to a level which might depress plant growth. Liming increased the yield of beans but no significant interaction between base saturation and salinity on yields was obtained. The chemical composition of the plant was more closely associated with the composition of the soil solution than the exchangeable cation composition. In some instances the interaction between salinity and base saturation treatments on plant composition was significant.

SWCRD, ARS, USDA, Norfolk, Va.

Brill, G. D., Campbell, J. C., and Blake, C. R. IRRIGATION AND SOIL MANAGEMENT STUDIES WITH POTATOES IN NEW JERSEY. *N.J. Agr. Expt. Sta. B.* 797, 14 pp. 1961.

Rotation-Irrigation Study--When compared with potatoes grown continuously, potato yields were increased 45 bushels per acre, or 18 percent when grown in a 2-year rotation

of potatoes and wheat, and 56 bushels, or 23 percent, in a 3-year rotation of potatoes, wheat, and sod. Yields on the 2-year and 3-year rotations were nearly the same under irrigation, but without irrigation yields tended to be higher on the 3-year rotation.

Wheat yields tended to increase over the years and were slightly higher on the 3-year rotation than on the 2-year rotation. In the last 2 years of the study, irrigation of potatoes seemed to decrease the wheat yields of the following year, partly because of fertility differences, since nonirrigated potatoes may not have utilized the entire fertilizer application.

Quality of potatoes was improved by both the 2- and 3-year rotations. In dry years irrigation also improved the quality of potatoes.

Rotation also improved soil physical condition, as indicated by measurements of aggregate stability and soil density, and as reflected in the depth to which the potatoes used moisture, indicating an improvement in soil structure below the plowed layer.

Frequency And Amount Of Irrigation--Over a 3-year period, potato yields on a Sassafras 1 were equally good, regardless of whether they were irrigated when 33, 50, or 67 percent of the available soil moisture had been depleted. At the 67 percent moisture depletion level, yields tended to be higher with 2 inches of irrigation than with 1 inch. In the rainless periods of June, July, and August, when 1.0 inch of water was added, soil moisture was depleted at all levels in about 6 days; with an application of 1.5 inches in 8-9 days; and with 2.0 inches in 10-12 days. The use of the larger quantity at less frequent intervals might reduce labor costs in moving pipe or reduce the amount of equipment needed.

SWCRD, ARS, USDA, and N. J. Agr. Expt. Sta., Rutgers-The State U., New Brunswick, N.J.

Harris, K., Erie, L. J., and Peterson, B. COTTON IRRIGATION IN THE SOUTHWEST.  
U.S. Dept. Agr., Agr. Res. Serv., ARS 41-26, 13 pp. 1959.

In a study of irrigation of cotton in the Southwestern part of the United States, the authors concluded:

1. Three methods of irrigating cotton are in common use in the Southwest: (1) Furrow; (2) level border or basin; and (3) sprinkler.
2. Cotton roots may penetrate to depths of 6 feet or more in deep, well-drained soil in the Southwest. On such soils, deep root penetration with adequate fertilization is usually associated with high yields. Shallow water penetration, tillage pans or other dense soil layers, poor soil aeration, adverse soil temperatures, high salt concentrations, and plant root diseases or parasites may limit root penetration and thus reduce yields.
3. Good water penetration at the preplanting irrigation for deep soil moisture storage and/or for leaching of salts is best obtained by applying the water immediately after plowing thoroughly dry soil.
4. Cotton plants use between 25 and 45 inches of water annually depending upon prevailing agronomic and climatic conditions.
5. In areas of low rainfall, most of the water used by the cotton plant must be supplied by irrigation; however, where appreciable rainfall occurs during the growing season, the irrigation schedule should be adjusted according to the intensity and distribution of precipitation. Delaying irrigation in anticipation of rainfall may result in moisture stresses that severely reduce yields.
6. In arid areas, adequate preplanting irrigation is desirable. If deep water penetration is secured at this time, subsequent irrigations need not wet the soil profile deeper than 2 to 4 feet.

7. An early irrigation when soil temperatures reach about 90° F. at the 6-inch depth may be desirable to lower soil temperature as well as to supply moisture.
8. Any procedure that encourages rapid growth of cotton plants during the early part of the season usually increases yield. Irrigations early in the season, but only after the soil is warmed up, usually increase yield and usually increase early vegetative growth.
9. Excessive vegetative growth should not be encouraged after the first bolls have opened. Vegetative growth can be retarded and fruiting may be encouraged by withholding irrigation until the plants show a slight moisture stress.
10. Even though the consumptive use rate is reduced in late summer and fall, cotton needs some water to mature the bolls. If deep water penetration exists on deep, well-drained soils at planting time, cotton plants will usually obtain sufficient moisture from the lower depths to supply the plant needs late in the season. If deep penetration was not obtained or if the soil or root system is shallow, irrigation should be continued later in the season.

ARS, USDA, Inform. Div., Washington 25, D.C.

Robins, J. S., and Howe, O. W. IRRIGATING DRY BEANS IN THE WEST. U.S. Dept. Agr. L. 499, 6 pp. 1961.

Irrigation water should be applied within 3 to 5 days after the bean foliage turns dark bluish green. Color will change in spots in the field; these areas give an advance indication of the conditions over the whole field. If irrigation is delayed more than 7 to 10 days after the changes in these spots, yields may be reduced. Such delay before blooming also delays crop development and harvest. After the crop has reached a growth stage wherein it is difficult to detect the color change, the table below will help to determine if it is time to irrigate.

The quantities of water indicated in the table are general estimates designed as guides to the proper amount of irrigation water to apply when the foliage color change occurs. The times between irrigations indicated in the table are guides to the general frequency of irrigation necessary to maintain good growth.

The number of irrigations required during the growing season may vary from none, if enough rainfall occurs at the right time, to six or more on sandy soils in arid areas. Cool, cloudy weather will extend intervals between irrigations.

Unless surface soil moisture is adequate for good seed germination, a preplanting irrigation should be applied. This irrigation will insure adequate subsoil moisture reserves for the crop to draw on. If irrigation water becomes too scarce, the preplanting irrigation may lessen the drought hazard if the crop removes all the available water from the surface layer.

Do not overirrigate; allow the water to run in the furrow only as long as necessary to wet the soil in the root zone to field capacity.

Apply the last irrigation early enough that the crop will extract most of the water from the soil layers at cutting time. A dry surface will make it easier to cut and thresh the beans and will prevent pods from rotting or the seed from becoming discolored.

## Guides in irrigating dry beans in the Western United States

Plant development		Water use rate	Moisture supply available to plants if soil is filled to capacity for <sup>1</sup> --			Time between irrigations <sup>2</sup>		
Stage of bean growth	Root zone depth		Sandy soils	Loams	Clays	Sandy soils	Loams	Clays
		Inches per day						
2 to 3 weeks after emergence . . . . .	Feet	Inches	Inches	Inches	Inches	Days	Days	Days
	1.0	0.075	0.5-0.9	0.9-1.3	1.3-1.7	7-12	12-17	17-23
Early bloom . . . . .	2.0	.125	.9-1.6	1.6-2.2	2.2-2.8	7-13	13-18	18-23
Pod development .	2.5	.25	1.1-1.9	1.9-2.6	2.6-3.3	4-8	8-10	10-13
Pod maturing . . .	3.0	.20	1.3-2.3	2.3-3.1	3.1-3.9	6-11	11-15	15-20

<sup>1</sup> This value also denotes the amount of water needed to refill the root zone when plants change color. The range in values is due to soil variations within a textural grouping. Sandy loams hold less than silt loams, sands less than loamy sands, and silty clays less than clays. In irrigating, add 15 to 25 percent more water to take care of evaporation and deep percolation. That is, if 1.6 inches are needed for early-bloom stage of beans in a loam soil, apply 2 inches of irrigation water exclusive of runoff at the lower end of the field.

<sup>2</sup> The range in time between irrigations is due to climatic variations as well as variations in moisture supply for different soils within a textural grouping. In hot, dry, windy weather, irrigation is needed oftener than in cool, humid periods.

ARS, USDA, Inform. Div., Washington 25, D.C.

Howe, O. W., and Rhoades, H. F. IRRIGATION OF GREAT NORTHERN FIELD BEANS IN WESTERN NEBRASKA. Nebr. Agr. Expt. Sta. B. S B 459, 28 pp. 1961.

Irrigation experiments with field beans were conducted at the Scotts Bluff Experiment Station at various times from 1935-56. All experiments were on Tripp vfls. Particular attention in the latter experiments were given to timing of irrigation in relation to plant development. Some of the results and recommendations based on the results are:

1. A change in color of the plant foliage from light to dark green is a useful guide to the proper time of irrigating varieties of field beans grown in this locality. This change in color happened at approximately the same time the readily available moisture in the top foot of the soil was reduced to 50 percent of that at field capacity.
2. The entire root zone of the soil should be at or near field capacity wetness at planting time. It should be completely refilled to field capacity at each irrigation. Good cultural practices, including adequate seeding rate, fertilization, and weed control, should be followed.
3. An early irrigation is important. This irrigation applied during the early vegetative period at the beginning of the color change, increased yields from 3.8 to 11.7 bushels per acre as compared with delayed irrigation.

4. After an early irrigation, a second irrigation may be delayed, without any reduction in yield, as much as 21 to 26 days on soils of high water-holding capacity. During hot, clear weather, the second irrigation is needed at pod setting or early pod filling time or not later than 5 to 12 days after the foliage changed from light to dark green in color. Under conditions of cool, moist weather, delay applying irrigation water until either fair weather or strong drought symptoms occur.
5. Plant symptoms may indicate some drought distress 7 to 10 days after the second irrigation and a third irrigation should be applied if the weather is warm and dry. In periods of cool, moist weather, the third irrigation should be delayed for a few days after the color change indicates drought distress or until fair weather.
6. Maximum or nearly maximum yields are obtained during most years with three well-timed irrigations. However, a fourth irrigation may be desirable when the first pods are beginning to mature. An examination of the soil to a depth of 2 feet is recommended to determine the need for a fourth irrigation.
7. Under conditions of a limited irrigation water supply, reasonably good results can be expected from one or two well-timed irrigations. Where only one irrigation is applied, irrigate at the time pods are beginning to fill or at any earlier time when drought distress becomes so severe that growth has apparently ceased. Two irrigations should be handled in the same manner as described in item 4. Remember, these recommendations are based upon a medium textured soil. Very sandy soils will require more frequent irrigation and fine textured soils less frequent irrigation.
8. Great Northern Field beans use about 12 inches of water during cool growing seasons and about 16 inches of water during warm growing seasons in this area. About 60 percent of the total water comes from irrigation, 40 percent from rainfall and soil storage.
9. Irrigating every other furrow appears satisfactory for field beans grown in 22-inch rows, providing water remains on the set nearly twice as long compared to every-furrow irrigation.
10. Field bean production under basin irrigation has been successful except that prolonged submergence damaged the plants. It may be necessary at times to drain the basins of excess water.

U. Nebr. Col. Agr., Agr. Ext. Sta., Lincoln, Nebr.

Cannell, G. H., Voth, V., Bringhurst, R. S., and Proebsting, E. L. THE INFLUENCE OF IRRIGATION LEVELS AND APPLICATION METHODS, POLYETHYLENE MULCH, AND NITROGEN FERTILIZATION ON STRAWBERRY PRODUCTION IN SOUTHERN CALIFORNIA. Proc. Amer. Soc. for Hort. Sci. 78: 281-291. 1961.

Studies were conducted relating irrigation treatments with N fertilization, irrigation application, and clear polyethylene plastic mulch vs. no-plastic mulch.

Fruit yields, both sound and rotted fruit, were increased with increasing soil moisture. Rotted fruit yields were higher under sprinkler irrigation than with furrow irrigation.

Fruit yields were not significantly increased when N fertilization was increased from 50 to 100 pounds per acre.

Runner counts for 10 plants in each treatment, taken at the end of the experiment showed runners to increase with decreasing soil moisture, plastic mulch, and increased N.

Leaf samples taken at 3 dates during the harvest season showed that K, P, Ca, N, and Mg decreased with time. The uptake of N was significantly increased with decreasing soil moisture.

The day and night temperatures of soil beds early in the season were higher under plastic than for no-plastic mulch. Soil bed temperatures later in the season were similar

under the mulch treatments. The more favorable soil growing conditions for plants under plastic mulch early in the season accounted for larger yields when compared to no-plastic. In the late yield period, plants under plastic mulch changed from sexual to asexual reproduction approximately 4 weeks earlier than under no-plastic. As a result, late yields were greater in the no-plastic treatment. Plastic mulch from a total yield basis was not superior to no-plastic. However, the increased early yields under plastic mulch are important to southern California growers because fruit prices are usually much higher during the early yield period.

U. Calif., Riverside, Calif.

Nelson, C. E., and Roberts, S. AGRONOMIC EVALUATION OF EIGHT GRAIN SORGHUM VARIETIES UNDER IRRIGATION AND A METHOD FOR PREDICTING POTENTIAL STALK BREAKAGE. Wash. Agr. Expt. Sta. B. 626, 10 pp. 1961.

Eight varieties of grain sorghum were grown in a randomized split-plot experiment at five plant population levels. Separate germination tests were made of each variety. Adjustments were made for germination in the seeding rates. After counting the seeds for a given plant population and variety, small diameter tubes were made to hold a given number of seeds. The seeding was done with a belt-type machine. A correlation ( $r = 0.92$ , 158 d.f.) was obtained with seeding rates and stands. There was no advantage in this experiment from using the 'cold test' when the seed was planted in soil averaging  $60^{\circ}\text{F}$ . at a 6-inch depth.

Six of the varieties produced between 140 and 156 bushels per acre. Ryer 15 and NK 120 had the driest grain on October 11. On November 15, the grain moisture percentages were not significantly different, ranging from 17.2 to 18.3 percent--considerably above the 12.0 percent required for safe storage.

Differences in tillering, expressed as heads to plant ratio, between varieties ranged from 0.86 to 1.21 heads per plant. Tillering decreased as plant populations increased.

Grain yields increased with plant populations up to 150,282 plants per acre and were similar for 192,100 and 234,788 plants per acre.

Mechanical breakage tests of the stalks at the time of heading were correlated at the 1 percent level with field stalk breakage in the fall from natural causes.

The resistance of the stalks to mechanical breakage decreased as plant populations increased. From the standpoint of potential stalk breakage from natural causes, it is undesirable to use higher seeding rates than necessary to obtain maximum yields.

The height of stalk and weight per head must be used in conjunction with the mechanical breakage test in comparing varieties. There are differences in wind resistance in relation to plant height and leverage effects in conjunction with head weight.

Stalk breakage does not always occur, owing to the vagaries of the weather. Therefore, a method of converting plant height, mechanical breakage resistance of the stalk, and head weight into a "stalk breakage factor" for predicting stalk breakage in the field from natural causes are described.

Wash. Agr. Expt. Sta., Inst. Agr., Sci., Wash. State U., Pullman, Wash.

Hughes, W. F., and Magee, A. C. INCOME POSSIBILITIES FROM IRRIGATED CASTOR-BEANS, TEXAS HIGH PLAINS. Tex. Agr. Expt. Sta. M-P 493, 44 pp. 1961.

Irrigated castorbean production is a relatively new enterprise on farms of the High Plains. Castorbeans compete with grain sorghum for land and water that are surplus to

cotton requirements. Castorbeans usually receive about the same amount of irrigation, about 50 percent more fertilizer, and considerably more hoeing than grain sorghum averaging 4,500 pounds per acre.

At 1959 price and yield levels, the return from castorbeans averaged about \$9.00 per acre more than similar returns from grain sorghum. Assuming a general yield relation of 1,600 to 2,000 pounds of castorbeans per acre and 4,000 to 5,000 pounds of grain sorghum per acre, castorbeans at 5 cents per pound can compete favorably with grain sorghum at \$1.50 to \$1.75 per 100 pounds.

Tex. Agr. Expt. Sta., College Station, Tex.

Technical Sub-Committee on Northeast Regional Research Project NE-33. EVALUATING THE PROFITABILITY OF IRRIGATION ON NORTHEASTERN DAIRY FARMS. N. H. Sta. B. 469, 26 pp. 1960.

How to get more forage and expand the herd size of a particular Northeast dairy farm were investigated from the standpoint of several different production possibilities. The partial budgets indicate that adding irrigation may be profitable but that other alternatives may also be profitable. This is what the farmer finds when he weighs the merits of the several alternatives in terms of their effects upon net income. In addition, he will want to look at the capital and labor requirements needed to make the changes. A summary type comparison for this purpose is shown in a table.

In doing the partial budgeting it was assumed that sufficient capital and labor could be obtained to make any of the changes under consideration. Nevertheless, the farmer might prefer a less profitable production change to a more profitable one, if the capital and labor requirements of the less profitable ones are decidedly lower. In many realistic situations limitations on the availability, of capital and labor play an important part on a farmer's choice of production practices.

The farmer would probably take note of the comparatively high capital investment and labor requirements needed to make the change to irrigation. Also, the income prospects for irrigation are not as great as some of the other alternatives. From the income standpoint, the "high fertilizer" and "rent land" alternatives look good. Part of the reason for favorable returns on these two is that they offer an opportunity for utilization of the present crop machinery and some other fixed resources more fully. If this farmer wanted to expand his milking herd with a minimum of new capital investment and without hiring extra labor, then the "purchase replacements" looks like the alternative for him.

Throughout the report emphasis was placed on the evaluation of individual production practices. Actually some combination of the several alternatives may be the best solution. For example, if the farmer applies more fertilizer, rents additional land, and replaces his corn grain with corn silage, he can almost double his herd size. Another combination might include adding irrigation, applying more fertilizer, and purchase replacements instead of raising them. Again the availability of capital and labor plays an important part in the selection of some combination of alternatives. When major expansions and adjustments are under consideration, the problem may involve a different scale of production techniques than those presented for this problem.

Table.--Changes in Number of Cows, Net Returns, Investment and Labor Requirements by Alternatives

Alternative	No. of Cows	Changes in:		
		Net Returns to Operator Labor and Management	Invest- ment	Labor Require- ment
A. Irrigation:		(Dollars)	(Dollars)	(Hours)
.5 ton yield response..	3	-66	6,983	324
1.0 ton yield response..	7	893	9,883	508
B. Green-Chop (soilage, zero-grazing).	2	52	2,988	440
C. Purchase Replacements...	6	310	1,350	0
D. High Fertilizer. ....	9	2,892	6,750	418
E. Corn Silage.....	9	584	6,750	333
F. Buy Hay .....	5	383	3,800	200
G. Rent Land.....	5	1,195	3,800	340
H. Feed More Grain .....	3	-109	2,400	120

Twenty-five tables presented.

N. H. Agr. Expt. Sta., Col. Agr., U. N. H., Durham, N.H.

Agricultural Research Service. IRRIGATING TOBACCO. U.S. Dept. Agr. Farm. B. 2159, 12 pp. 1961.

A farmers' bulletin that discusses the general principle of irrigating tobacco.

ARS, USDA, Inform. Div. Washington 25, D.C.

Carlson, C. W., Grunes, D. L., Fine, L. O., Reichman, G. A., Haise, H. R., Álessi, J., and Campbell, R. E. SOIL, WATER, AND CROP MANAGEMENT ON NEWLY IRRIGATED LANDS IN THE DAKOTAS. U.S. Dept. Agr., Prod. Res. Rpt. 53, 34 pp. 1961.

In the Dakotas, estimates indicate that a potential 1-1/2 million acres of land can be irrigated from the Missouri River. Successful conversion from dryland to irrigation agriculture over such a vast area presents many soil, water, and crop-management problems. Agriculturists have answers for only a few of them in an area where irrigation has been of minor importance. This report summarizes the principal findings from a research program of soil, water, and crop management conducted from 1950 through 1958, by the Soil and Water Conservation Research Division of the Agriculture Research Service in cooperation with the North and South Dakota Agricultural Experiment Stations and the U.S. Bureau of Reclamation on development farms provided by the latter agency.

The Garrison Diversion Unit in central and eastern North Dakota, and the Oahe Unit in north-central South Dakota are parts of the proposed water development plan of the Missouri River basin project. The Oahe Unit is estimated to include more than 500,000 irrigable acres and the Garrison Diversion Unit, about 1 million acres.

SWCRD, ARS, USDA, Beltsville, Md.

A linear program analysis of farm adjustments to changes in water supply was made. Various incremental or marginal values of water were estimated. Several factors that affect the value of irrigation water were considered and their effect estimated within different assumptions about labor supply. These factors were land productivity, efficiency of water use, timing and level of water supply, and number and kinds of enterprises.

Three farm models having different enterprise alternatives were used in the analysis. Fixed resources or limitations in the models consisted of land, monthly labor, operating capital, and monthly water supplies. Solutions were programmed for three monthly water supply situations. Other resource limitations, prices, and inputs per acre were held constant throughout the analysis.

Three different output situations were considered to take into account differing land productivities. Water-use efficiency levels of 40, 50, and 60 percent were considered as they affected water values.

Estimated marginal water values varied from 39 cents to approximately \$41 per acre-foot over the range in variation of the above factors. The middle estimates of marginal water values dropped from \$18.17 to \$8.99 as water supply increased from 2.18 to 3.02 to 3.67 acre-feet per acre. The calculations from the models demonstrate the need for differentials in supply when allocating water to individual farms, or the economic advantages of a free market for water.

Labor use increased by approximately 35 to 50 percent for the various models when water supply increased from 2.18 to 3.02 acre-feet per acre. This major change in labor use indicates the need in project evaluation for considering the cost and availability of labor resources needed to utilize supplemental water from the project.

The farm model having a livestock enterprise gave the largest estimates of water values. This resulted because the livestock operation provided a better market for crops than selling on the open market.

Agr. Expt. Sta., Colo. State U., Fort Collins, Colo.

Staff Writer. HOW TO INCREASE YOUR IRRIGATION DIVIDENDS. Amer. Veg. Grower. 9(6): 22-23. 1961.

Use of an irrigation system should not be limited to just reviving and facilitating crop production during periods of drought, points out Dr. R. L. Carolus, Michigan State University, East Lansing. He suggests that it can be used to: (1) Aid in transplanting by wetting the field 24 hours previous to setting of plants; (2) facilitate pre-emergence weed control by allowing the chemical to penetrate deeper and by promoting early weed seed germination; (3) facilitate the rapid, even germination of pelleted seed; (4) permit the use of high quality, non-drought resistant varieties; (5) allow bedding and ridging of early planted warm season crops in cold wet soils which subsequently might result in injury due to drying out if not safeguarded by irrigation; (6) permit more efficient utilization of larger pre-planting fertilizer applications and of side-dressing and topdressing applications; (7) apply additional fertilizer in water through the system; (8) reduce the soluble salt injury during drought periods to heavily fertilized crops; (9) produce green manure crops for organic matter, following an earlier harvested cash crop; (10) prevent frost damage by irrigating dry soils 12 to 24 hours previous to cold period to increase temperature near ground by 3° to 6°F.; (11) prevent frost by sprinkling during low temperature periods (5° to 8°F. protection); (12) increase the rate and uniformity of growth and thereby the market and edible quality;

(13) increase the number and size of fruits; (14) prevent premature ripening and resultant poor quality; (15) hasten maturity; (16) facilitate seeding during dry periods and encourage evenness of stand and germination; (17) soften a crusting soil and facilitate seedling emergence; (18) prevent wind erosion of soil from damaging small emerging seedlings; (19) help reduce aphids and thrips and other insect populations; (20) facilitate plowing dry soils or in breaking up clods and lumps in soils that were plowed when too wet; (21) permit the production of a wider variety of crops during a longer season; and (22) improve the overall quality of all crops grown.

Amer. Vegetable Grower, Willoughby, Ohio.

Lanham, W. J. and Butler, C. P. IRRIGATION PRACTICES, COSTS AND RETURNS IN SOUTH CAROLINA, 1956-59. S.C. Agr. Expt. Sta. B. 496, 30 pp. 1961.

The recent widespread interest in irrigation and the potentiality of irrigation to raise farm incomes in South Carolina and in the Southeast occasioned additional research directed toward the possible economic advantages of this relatively new practice. Farmers' experiences with irrigation in 1956-59 were studied. Data on irrigation practices, costs, and returns were considered for the major irrigated crops in the area. Peaches and tobacco were the chief crops irrigated, followed in importance by pasture, corn, alfalfa, and cotton.

Supplemental irrigation systems require a large outlay of capital. The initial investment per farm was about \$3,800 for general-type farms, \$4,900 for dairy, \$5,800 for beef, \$6,700 for tobacco, and \$12,200 for peach farms. Capital outlay per acre irrigated or per unit of water used decreases rather sharply with an increase in acreage irrigated or in quantity of water used. The large capital outlay results in relatively larger fixed costs in relation to operating or variable costs.

Supplemental irrigation of peaches proved to be more profitable than irrigation of any other crop. Irrigation was profitable over the 4-year period for each crop irrigated for those farm operators who already owned irrigation systems.

The feasibility of buying an irrigation system can be more adequately determined by considering the returns to irrigation on a per farm basis when fixed as well as variable costs are included. The peach producers again had the largest net return associated with irrigation, with an average annual net increase of \$7,266 per farm for the 4 years. Dairy-type farms averaged \$992, beef \$574, general \$495, and tobacco \$318 per farm annual increases for the 4 years.

The success of supplemental irrigation as a farm practice depends upon a large number of variables; each farm operator must base his need for irrigation upon his own situation. Beyond the basic considerations of water supply, climate, and soil and crop characteristics is the need for observing correct farm management practices. Irrigation should not be considered a substitute for the performance of other recommended farming practices.

The allocation of resources for the development and installation of irrigation systems should be made after considering comparative profits from the use of the same resources in developing other alternative adjustments.

Tables and graphs.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

Evaporation and seepage of irrigation water in some areas can increase the cost of irrigation water delivered to the field.

To determine if evaporation and seepage were important factors in water cost in the Mississippi Delta, water losses were measured in irrigation channels in sandy, loam, and clay soils.

Due to peculiarities in these soil types it was found that the greatest losses were in clay soils and the smallest losses were in sandy soils. Extreme cracking in the clay soils caused higher losses, while a high percentage of silt in sandy soils causes a sealing which reduces water seepage in these soils.

Evaporation from irrigation channels was found to be of little significance.

When the low cost of pumping water in the area is taken into consideration, it becomes apparent that transportation systems which would reduce or eliminate the high water losses found in clay soils cost more on an annual basis than the value of the water lost during an irrigation season.

Pumping costs would need to increase considerably before it would pay to install distribution systems to prevent these losses.

ERS, USDA, and Miss. State U., Agr. Expt. Sta., State College, Miss.

## Drainage

Soil Conservation Service. SCS NATIONAL ENGINEERING HANDBOOK--SECTION 16:  
DRAINAGE--CHAPTER 1--PRINCIPLES OF DRAINAGE. U.S. Dept. Agr., Soil Conserv.  
Serv. Engineering Hbk. Sec. 16, Chapter 1, 31 pp. 1961.

The Soil Conservation Service National Engineering Handbook is intended primarily for Soil Conservation Service (SCS) engineers. Engineers working in related fields will find much of its information useful to them also.

The handbook is being published in sections, each section dealing with one of the many phases of engineering included in the soil and water conservation program.

Principles of Drainage, a review of the fundamentals needed by SCS technicians whose work includes drainage, is the first chapter of the Drainage Section (Section 16) to be offered for sale.

\$0.35 Supt. Doc., Govt. Printing Off., Washington, 25, D.C.

Toksoz, S., and Kirkham, D. GRAPHICAL SOLUTION AND INTERPRETATION OF A NEW DRAIN-SPACING FORMULA. J. Geophysical Res. 66: 509-516. 1961.

A drain-spacing formula of one of the authors (Kirkham) which is based on rigorous mathematical procedures and which has been tested in the field is now presented in graphical and tabulated form. The formula is useful for computing the removal of steady excess rainfall or steady excess irrigation water. A special case of the formula is compared with a formula derived by Hooghoudt for which he utilized the assumption of radial flow. Since Hooghoudt showed that his formula applied either to the removal of steady surface-applied recharge or to artesian water originating from an aquifer at great depth, we conclude that

Kirkham's special formula applies also to surface recharge or to artesian water seeping upward from great depth.

J. Paper J-3983, Iowa Agr. And Home Econ. Expt. Sta., Ames, Iowa.

Anderson, J. R., and Dill, H. W. LAND CLEARING AND DRAINAGE IN EASTERN NORTH CAROLINA. U.S. Dept. Agr. Res. Serv., ARS 43-127, 47 pp. 1961.

Recent land drainage and clearing operations in selected areas of the Coastal Plain of eastern North Carolina were studied. The costs and benefits of clearing and draining land, the characteristics of the land cleared and drained, the types of equipment used, and the uses made of land improvements were analyzed.

The Coastal Plain of eastern North Carolina is nearly level in the extensive lower areas and rolling to hilly in the higher inner part. Two-thirds of the total land area is in forest. Estimates of the United States Soil Conservation Service indicate that if cleared and drained, more than one-third of the present forest area would be adapted to cultivation.

Since World War II, farmers have cleared thousands of acres of land for agricultural uses in the middle Coastal Plain and tidewater counties of eastern North Carolina. The acreage cleared in Beaufort, Pitt, and Robeson Counties, amounted to about 43,000 acres. The following kinds of land clearing were noted: (1) Clearing of land in blocks or tracts for establishing new fields; and (2) clearing associated with extending existing fields, cleaning out corners, wet spots, etc.

Nearly all of the clearing since 1950 has been done on land with light and medium forest cover densities. Per acre costs for clearing averaged \$70 for light cover, \$91 for medium cover, and \$173 for heavy cover.

Most clearings for agricultural use in recent years have been accomplished with bulldozers. A heavy bush and bog disk was generally used. Main ditches needed for drainage were usually dug with a dragline before the clearing operation began. Practically all of the land in eastern North Carolina was cleared by those who use their own land-clearing equipment or by farmers who had it done on a custom basis.

Uses made of recently cleared land varied among and within the four areas under study. Soybeans and corn were the most common first crops planted on newly cleared land. Improved pastures were initial uses on several tracts. Most farmers contemplated no future change in the uses of the newly cleared land from that adopted during the first 3 or 4 years.

For much of the tidewater area and for many parts of the middle Coastal Plain, the land must be drained for successful agricultural use. Nearly all of the early field drainage was accomplished by using small ditches with spoil banks left beside the ditches. Today, tractors, draglines, graders, and other equipment are used. Where the grade is sufficient, soil conditions permit, and it is economical, tile is used as a means of enlarging fields and improving their layouts in order to permit more efficient use of mechanized farm equipment.

Drainage activity in North Carolina is carried out generally in three ways: (1) By legally organized drainage districts; (2) by voluntary group drainage; and (3) by individual farmers.

Properly designed and constructed outlet ditches are vital to an efficient drainage system. The cost of outlet ditching averaged about \$1,800 per mile. This includes the cost of excavation, spreading of spoil, and some right-of-way clearing. The range in cost reported was from \$1,100 to \$2,500 per mile.

In eastern North Carolina, tile drains and open ditches are both used in draining farmland. Much of the tile drainage was installed mainly to drain wet spots. The cost of installing tile drainage averaged about 31 cents a foot from 1950 to 1958, inclusive. In order to accomplish spot or random drainage satisfactorily, about 200 feet of tile per acre is generally needed. The average cost of tiling land in this way was running about \$62 per acre for the farms studied in the four townships.

Most of the field drainage was done by draglines equipped with V-buckets. Per acre costs amounted to about \$11 or \$14. When the cost of digging and spreading the spoil banks of two lateral ditches needed as outlets for field ditches draining a section of land is added to the cost of field ditching, the cost amounted to about \$20 to \$22. This includes neither group drainage costs nor the cost of main canals dug in organized drainage districts. Another \$5 to \$10 per acre should be allowed for these costs.

ARS, USDA, Inform. Div., Washington 25, D.C.

Beer, C. E., and Shrader, W. D. RESPONSE OF CORN YIELDS TO BEDDING SOILS: SOME FIELD RESULTS FROM CONTROLLED DRAINAGE INVESTIGATIONS. *Agr. Engin.* 42: 618-621. 1961.

Bedding is not feasible on a Planosol soil (Claypan soils of flat lands) for conditions comparable to those described in this experiment, which include 100-ft. wide beds, 0.15 percent grade in the channel, and tillage operations performed at right angles to the direction of the grade. A summary for the period 1954-59 shows that the difference between the level and bedded plots is dependent upon the type of cropping system used. The yield on the bedded plots was depressed about 12.5 percent in the continuous corn system while in the C-O-M (Corn-oats-meadow) rotation, a slight (2 percent) increase in yield was obtained. The 6-year period is considered a fair test of the effect of bedding on yields since it contained years with wide differences in precipitation.

Within the bedded plots, the corn yield varied with respect to the position of the sampled area on the bed. The effect of disturbing and removing the topsoil to build up the crown or top of the bed, as well as year-to-year climatic factors, influenced the corn yields. When averaged over the 6-year period, the yield was much lower in the lower portion of the bed which is adjacent to and a part of the channel for the bedding system. The average differences in yield between the two positions are 21.8 and 23.0 bu. per acre, respectively, for rotation corn and continuous corn. These differences reflect a 22 and 34 percent reduction in yield in the lower positions. Higher rates of nitrogen are effective in offsetting the detrimental effects of the poorer environment in the lower position of the beds. A statistical test shows that, if yield was plotted as a function of increasing nitrogen application, the yield increase per pound of nitrogen added at the higher nitrogen applications is greater in the lower position than in the upper position of the bed.

Iowa State U., Ames, Iowa.

Todd, D. K., and Bear, J. SEEPAGE THROUGH LAYERED ANISOTROPIC POROUS MEDIA. *J. Hydraul. Div., ASCE* 87(HY 3): 31-57. May 1961.

An investigation of seepage from leveed rivers into low-lying adjoining agricultural lands is summarized. Only the flow rate and distribution of seepage as a function of the surface and subsurface boundary conditions were studied. Flow nets in idealized cross sections were determined by an electric analogy model. Boundaries represented channel bed and bank, a levee base, a lower impermeable stratum, and the water table in adjoining drained agricultural land. Variables studied included two subsurface layers of different permeabilities and anisotropics, layer arrangements and thicknesses, channel depth and width, levee base width, and water table slope.

U. Calif., Berkeley, Calif.

The design of interceptor drainage systems is complex and often hampered by lack of methods for analyzing variable permeability. An approximate method for including variable permeability in a design procedure is presented.

The analysis requires a watertable contour map for transposing the flow system in heterogeneous soil, to an equivalent system, having constant permeability throughout. In the uniform system, equations derived for homogeneous soil can be applied. Reverse-transformation of the prediction from the uniform soil system to the field problem gives the expected condition after drainage facilities are installed.

Four things were accomplished with respect to a design method for interceptor drains in heterogeneous soils: (1) A transformation method was presented which allows any essentially lateral flowing system found in interceptor drainage problems to be changed into an equivalent system of uniform conducting material; (2) if the water table or characteristic flow geometry can be predicted in the equivalent uniform system, then the expected conditions after drainage can be determined through a reverse transformation; (3) the transformation and reverse transformation can be accomplished in a simple graphical way; and (4) the quantity of water entering the drain is directly determined if the inflow to the drain in the uniform system can be predicted.

Geochemical and Geophysical Res., Hanford Atomic Products Operation, General Electric Co., Richland, Wash.

Schwab, G. O., Fouss, J. L., and Leech, A. P. RATE, DURATION, AND FREQUENCY OF TILE FLOW. Agr. Engin. 42: 546-549. 1961.

Eight years of tile flow records of Tiffin, Ohio, were evaluated for drains at 2- and 3-ft. depths and at spacings of 30 and 60 ft. in all combinations. Only part of the data is reported. The 4-month total flow for March through June and the annual flow were compared for all crops in a 2-year rotation and in a 4-year rotation. The crops included corn, small grain, and first- and second-year meadow. The following are the principal conclusions:

1. Annual tile flow varied considerably from year to year, and the percentage variation was much greater than annual precipitation.
2. The highest monthly flow for the year occurred in March, followed by April. During the winter months, the flow was quite high. The winter months were not considered as important in terms of crop production as the 4-month period March through June. Practically no flow occurred during the months of August, September, and October.
3. In general, the highest peak flow, the greatest volume of flow, and the total number of days of flow greater than 0.01 in. occurred in March and decreased in order for the months of April, May, and June.
4. For corn in the 2-year rotation and for tile at 3-ft. depth and 60-ft. spacing, the duration of flow at 3/8 in. per 24 hr. or greater was only 1.1 days, or about 1 percent of the time, during the 4-month period March through June.
5. Corn in the 2-year rotation with tile at 3-ft. depth and 30-ft. spacing produced the highest 4-month total and highest annual flow of any crop or combination of drainage system. However, corn and second-year meadow in the 4-year rotation gave the lowest flow primarily due to low antecedent moisture conditions.
6. The 4-month total and annual flow in inches from tile at depths of 3 ft. were greater than the flow from tile at 2 ft.

7. The tile flow in inches from the 30-ft. spacings was considerably greater than that from the 60-ft. spacings for both the 4-month period, March through June, and the calendar year. On the basis of the actual flow per linear foot of tile, the 60-ft. spacings gave about 40 percent more flow than the 30-ft. spacings.
8. The duration or percentage of time for various daily flow rates during the 4-month period, March through June, was not consistent among the various depth and spacing combinations.

Ohio Agr. Expt. Sta., Wooster, Ohio.

**Haynes, H. D. MACHINES FOR SURFACE DRAINAGE:\***

\* Part 1. Land and Water Contracting. 3 (8): 10-11, 14-15, 1961.

\* Part 2. Land and Water Contracting. 3 (9): 14-15, 18, 1961.

\* Part 3. Land and Water Contracting. 3(10): 10-11, 1961.

A three part article on machinery and procedures employed in good surface drainage in humid areas of the United States. The first part stressed rough grading; finish grading and continuing maintenance are discussed in the second part; and costs are discussed in the third part.

Caterpillar Tractor Co.

**Wilson, R. G., and Frederick, W. J. IRRIGATED LAND NEEDS DRAINAGE TOO: COLORADO FARMERS SOLVED LOCAL PROBLEM WITH GROUP PROJECT. Land and Water Contract. 3 (11): 9. 1961.**

Disposal of excess water can be as important on irrigated lands of the drier regions as on the too-wet lands of humid areas, and it may present just as serious a problem in the development of a program of conservation management.

Usually, if the problem is solved, it must be done by the farmers working together. Eight neighboring farms in Big Thompson (Colorado) Soil Conservation District had such a problem.

A solution was found in an outlet to nearby Little Thompson River, a part of the South Platte River system. The outlet was planned to be big enough to serve existing and proposed farm systems. Twenty-seven hundred feet of 12-inch tile and 3,850 feet of 10-inch tile went into this part of the project.

A total of 11,000 feet of smaller 6- and 8-inch tile was serving 400 acres already. The plan called for an additional 20,000 feet of the smaller size to serve the remaining 600 acres.

Cost of the improvement is expected to be from \$85 to \$100 an acre, about \$90,000. This is not excessive when you consider the value of the farms involved is from \$500 to \$1,000 an acre.

SCS, USDA, Littleton, Colo.

**Kaser, R. F. IRRIGATION AND DRAINAGE STUDIES OF TEXAS RIVERS. J. Irrig. and Drain. Div. ASCE 87 (IR 3): 13-36. Sept. 1961.**

In recognition of the need for comprehensive planning for water resource developments in Texas from a national as well as a regional or local standpoint, a new type of planning

agency was created by Congress in 1958. Title II of Public Law 85-843, 85th Congress, approved August 28, 1958, created the United States Study Commission-Texas as an independent, temporary agency reporting to the Executive Office of the President.

The area assigned to the Commission for study includes the watersheds of all of the intrastate rivers of Texas and intervening areas tributary to the Gulf of Mexico in Texas. This includes the drainage areas (from east to west) of the Neches, Trinity, San Jacinto, Brazos, Colorado, Guadalupe, San Antonio, and Nueces Rivers. Intervening areas include the watersheds of the San Bernard, Navidad, Lavaca, Mission, and Aransas Rivers. The Study Area includes about 62% of the land area of the state, and encompasses all that area of Texas which drains to the Gulf of Mexico through channels other than the Rio Grande and the Sabine River. The scope of this paper is limited to the Study Area of the U.S. Study Commission-Texas.

In this study the author concluded that:

1. The acreage of crops irrigated each year in the State of Texas has increased from about 1 million acres at the start of World War II to 6,750,000 acres in 1958. 4,600,000 acres (68%) are in the Study Area of the U.S. Study Commission-Texas.
2. Ground-water irrigation in the High Plains of Texas, which has been developed since World War II and comprises more than half of the 4,600,000 acres irrigated in the study area in 1958, is a 'mining' operation which will exhaust its economically usable water supply within the next 50 yr.
3. Although more than 18,000,000 acres of land in the study area are suitable for irrigation, only a small portion of those lands will ever be irrigated due to limitations of available water supplies.
4. Over 6,000,000 acres along the east Texas Gulf Coast are inadequately drained and are feasible for drainage. Half of that acreage is presently in cropland.
5. Present technology and proven management practices not yet in general use may be expected to result in future crop yields, both with and without irrigation, which greatly exceed present yields.
6. Agricultural production in the Study Area for the next 50 years can meet production goals, representing an equitable portion of the food and fiber requirements of a nation with a population of 380,000,000 people, without additional water resource developments, by feasibility changes in land use.
7. There is no compelling need, from the national standpoint, to promote large-scale irrigation or drainage improvements in the study area. Local interests, however, may be expected to prefer such improvements over alternative land use changes, where opportunities exist and economic advantages can be realized thereby.
8. Planning water resource utilization in the area of concern to the U.S. Study Commission-Texas can be based on: (1) Projections of irrigation and drainage improvements that may be developed by or for the people of the area on the basis of local desires; instead of (2) a need for project developments to increase agricultural production to meet national requirements.

Chf. Planning Engin., U.S. Study Comm. Tex., Houston, Tex.

### Storage and Conveyance

Crow, F. R. REDUCING RESERVOIR EVAPORATION. Agr. Engin. 42: 240-243. 1961.

The results of 4 years of research on the suppression of evaporation from experimental reservoirs by chemical films of hexadecanol and octadecanol are presented. The development of an experimental apparatus for the continuous application of a slurry of water and

powdered hexadecanol is described. With this system it was possible to maintain a chemical film on the experimental pond for prolonged test periods. Evaporation was reduced by 25 percent during a 66-day test in 1959. Water temperature increased as a result of the evaporation suppression. At the surface the water temperature was increased by 5.4° F., and at the 5-foot depth the temperature was 3.0° F. higher than that of the check reservoir.

An experiment was performed to determine the effect of intermittent application of the film. When the film was applied only 12 hours per day, evaporation was reduced by 6.5 percent, compared with 25 percent reduction when the film was applied 24 hours per day. The apparent cause for this difference is the higher energy content of the reservoir on which evaporation has been suppressed, resulting in higher evaporation rates when the film is removed.

Tests were made to determine the effect of wind speed on the rate of removal of the film. The equation for this relationship was found to be  $R = 0.0000093 U^{2.02}$ , in which R is the application rate of hexadecanol required for a continuous film, in pounds per hour per foot of upwind shore line normal to the wind, and U is the wind speed in miles per hour two meters above the water surface.

An economic analysis to determine the cost of saving water by evaporation retardation during an 11-day period of typical August weather showed the cost to be 89 cents per thousand gallons. This cost will vary for other locations, depending on the factors of climate, daily wind speed, and the shape and orientation of the reservoir with respect to prevailing winds.

Okla. State U., Stillwater, Okla.

## BASIC SOIL PROBLEMS

### Soil Physics

Sillanpaa, M., and Webber, L. R. THE EFFECT OF FREEZING-THAWING AND WETTING-DRYING CYCLES ON SOIL AGGREGATION. *Canad. J. Soil Sci.* 41: 182-187. 1961.

(1) Natural aggregates 2 to 3 mm.; (2) aggregates  $< 0.25$  mm, prepared by crushing 2- to 3-mm. aggregates; and (3) aggregates  $< 0.25$  mm, obtained by sieving the dry soil, were acquired from the Waupois sil.; the mean weight-diameter (M.W.D.) was determined after wet-sieving. Cycle of wetting and drying increased the M.W.D. of the largest aggregates but did not cause significant changes in the fractions  $< 0.25$  mm.

Cycles of freezing and thawing at moisture contents near saturation significantly decreased the M.W.D. of the large aggregates and increased the M.W.D. of the crushed aggregates at both rates of freezing. A significant decrease occurred in the M.W.D. of the original aggregates  $< 0.25$  mm. at the slower rate of freezing.

Ontario Agr. Col., Guelph, Ontario, Canada.

Buehrer, T. F., and Deming, J. M. FACTORS AFFECTING AGGREGATION AND PERMEABILITY OF HARDSPOT SOILS. *Soil Sci.* 92: 248-262. 1961.

A comparative study was made on two Arizona soils (McClellan and Mohave), which in certain areas exhibit an unusually high degree of compaction, in contrast with the same soil series in areas where the soil is aggregated and structurally more favorable to soil and water movement and plant growth.

The "hardspot" condition is characterized by a highly compact, slowly permeable surface layer, low in organic matter, high in colloidal clay, and firmly cemented with carbonates of calcium and magnesium. This layer is characterized by comparatively high capillary porosity and low rate of rise of water by capillarity.

The hardspot soils are characterized by the predominance of micro-aggregates, of which 97 percent are less than 0.2 mm. in diameter.

The well-aggregated soils were found to contain montmorillonite as the dominant clay mineral, whereas in the hardspot soils, illite was the predominant mineral. A high degree of correlation was found between degree of swelling of the colloidal clay with percentage of montmorillonite, and a close negative correlation with percentage of illite. Fracturing of the colloidal clay upon drying was observed to be extensive in the normal soils high in montmorillonite and very slight in the hardspot soils. Illite, with its slight lattice expansion in water as shown by swelling measurements, is concluded to be responsible in part for the compact condition of hardspot soils, together with the cementing action of calcium and magnesium carbonates.

The relative uniformity of texture throughout the profiles of these normal and hardspot soils makes either ripping or deep-plowing impractical as a corrective measure for the hardspot condition. Studies on aggregate distribution by wet-sieving soil samples from hardspot areas, by incorporation of gypsum with and without organic materials such as manure, ground alfalfa hay, ground barley straw, and sewage sludge, showed the extent of amelioration of this condition that may be expected from such treatments. Gypsum together with either manure or sewage sludge gave the greatest increase in aggregation.

Tables, graphs, and photos.

U. Ariz., Tucson, Ariz.

Plotnikov, A. A. THE DYNAMICS OF WATER-STABLE SOIL STRUCTURE IN A GRASS-ARABLE ROTATION. Soviet Soil Sci. 10: 1104-1107. Oct. 1960.

The dynamics of water-stable structure was studied on sod moderately podzolized silty clay loam for a number of years. Its potential capacity for aggregation is slight, since the amount of clay and fine silt does not exceed 13.7%, and the humus content is approximately 2%. The study was mainly centered on an experimental rotation in a field of the college farm at the Ivanov Agricultural Institute.

The author concluded this:

1. The seasonal dynamics of water-stability in soil structure are intimately connected with hydrothermal conditions and especially with the dynamics of soil moisture. The vital activity of plants has some influence in increasing the water-stability of soil aggregates. Perennial grasses do not have basic advantages over annual crops in this respect.
2. The withdrawal of the effect of plants on the soil after harvest leads to a gradual destruction of the structure formed during the growing period. This process is impeded by the addition to the soil of organic matter in the form of fertilizers. Perennial grasses aid in the retention of the soil's structural condition in the fall and in some cases improve it, since they continue to interact with the soil and maintain it in a compact condition.
3. Excessive wetting of the soil in the late fall (before freezing), and in the early spring (before physical maturity of the soil) causes the water-stability of the structure to be decreased. The soil is simultaneously broken down--the quantity of the agriculturally most valuable aggregates decreases. This process is most clearly

seen under vegetation, and the water-stability of the aggregates is less affected from late fall through early spring on soil cleared of vegetation.

4. The reduction processes that develop when aeration is insufficient and the activating products (applied organic fertilizers, dead roots, and plowed-in stubble residues) present in the soil are one cause of the destruction of an agriculturally valuable structure when the plowing layer is excessively wet.

Amer. Inst. Biol. Sci., 2000 P St. N.W., Washington 6, D.C.

Johnson, W. H., and Buchele, W. F. INFLUENCE OF SOIL GRANULE SIZE AND COMPACTION ON RATE OF SOIL DRYING AND EMERGENCE OF CORN. Trans. ASAE: 170-174. 1961.

The effect of varying soil granule size, degree of compaction, and location of various granule sizes in the tilled profile, upon soil moisture loss and plant emergence was evaluated. The authors concluded that:

1. As granule size increased and compactive effort decreased, the over-all rate of soil drying increased and total emergence of corn was less complete.
2. The application of pressure reduced the slope, K, of the moisture content ratio-time curve, although only a slight and uncertain difference existed between 1.2 and 5 p.s.i.
3. The effect of granule size on K tended to decrease with the application of pressure.
4. Under the climatic conditions of the experiment with no radiant energy applied, the fine granules, 0.046 in. in diameter, did not require a pressure treatment to effect complete emergence.
5. The 5 p.s.i. pressure treatment delayed or inhibited emergence because of the dense, dried layer above the seed. Initial soil moisture was relatively high, however.
6. Little difference in drying rates as observed the 1.2 and 5 p.s.i. pressure treatments, suggested that low energy levels were required to effectively reduce the drying rate. Slight vibration also reduced drying rates.
7. The stratified treatments, 0.046-in. granules placed and compacted in the 1- to 2-in. level, reduced P and K over the no-treatment condition.
8. The fine, compacted, granule layer in the stratified treatment provided a layer of high resistance to the diffusion of water vapor, yet capillary movement was broken.
9. At no time was any compacted or stratified treatment, which used the 0.263-in. granule as the primary soil, as effective in reducing the drying rate as a reduction in granule size to 0.046 in. Even so, based on the possibility of soil crusting when an entire seedbed is of fine granules, a stratified treatment appears to be a desirable compromise treatment.
10. The lowest drying rate occurred when the 0.046-in. granules were subjected to some form of pressure treatment.
11. Completely covering the sample surface with a water-vapor permeable material, which had inherently a higher resistance to diffusion than the fine granule size, erased any effect of granule size on rate of drying and was effective in reducing the over-all drying rates.
12. The application of radiant energy increased the rate of drying and caused one-third to one-fourth of the water lost from the upper 3 in. of soil to be downward to deeper depths. The quantity of the water movement downward was independent of granule size, whereas water loss out the surface was not.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Possibility of increasing the cloddiness potential of soils by compaction was investigated by chiseling three soils containing 17, 33, and 46 percent clay at several bulk density levels. Tillage was accomplished with laboratory equipment.

Percentage of clods produced by the chisel was increased on all three soils by increasing soil bulk density. Total cloddiness after tillage was greatest on clay, but rate of increase was more rapid for silty clay loam and sandy loam.

Breakdown by weathering was evident on all soils, but to a greater degree on silty clay loam, and sandy loam. More high-density than low-density clods were still present after weathering.

Mechanical stability, as determined by resieving, was also increased on all soils by packing. Clay was highly stable throughout the range of densities studied. Silty clay loam, and sandy loam clods remaining after weathering were less stable than clay.

Crushing resistance of clods increased rapidly with drying if the soil had been packed to high bulk densities, but rather slowly if it had been packed to lower levels. Clay produced the strongest clods and sandy loam the weakest.

Both increases in bulk density and clay content caused the draft requirements to go up rapidly. A point of diminishing returns on clod yield was reached at about 77 and 86 percent maximum density, respectively, for clay and silty clay loam, i.e., draft requirements become so large compared to the increase in percentage of clods that further packing probably would be unprofitable.

SWCRD, ARS, USDA, Manhattan, Kans.

Trouse, A. C., Jr., and Humbert, R. P. SOME EFFECTS OF SOIL COMPACTION ON THE DEVELOPMENT OF SUGAR CANE ROOTS. *Soil Sci.* 91: 208-217. 1961.

Rooting characteristics of sugar cane in soils of varying bulk densities were empirically established, and the critical volume weights at which root proliferation is checked were determined. These observations parallel those of Veihmeyer and Hendrickson 1948, using the double dwarf sunflower, in which different soils showed different threshold densities with this plant. The deformations that occur in roots growing in compacted soils that are approaching the critical levels are believed to lower their efficiency in moving air, water, and nutrients into the plant. The radioactive rubidium tests showed that the deformed roots moved nutrients into the cane plants. The reduced efficiency did not indicate whether the restriction was entirely due to the soil's limiting the contract area or was also partly due to reduced physiological functioning of the roots.

It has not been determined whether the effect of soil compaction on cane roots is primarily due to mechanical resistance or to the effect of reduced permeability of gases through the compressed soil.

The effect of the bulk density of soil on the sugar cane plant was stressed; it was also observed that puddling of soil had its detrimental effects. Although the soil volume weight may not be increased under such conditions, the rate of gaseous exchange surrounding the actively functioning roots may be seriously impaired. This may account for the widely varying critical densities observed. The hydrol humic latosols puddle easily with relatively small compressive forces.

Expt. Sta., Hawaiian Sugar Planters Assoc., Honolulu, Hawaii.

In a study designed to determine the effect of varying bulk densities, both naturally and artificially produced, the following conclusions were reached:

1. A soil compaction device capable of turning out uniformly compacted cores of a predetermined, uniform bulk density ranging from 1.4 to 2.0 was developed.
2. A technique for determining the penetrability of artificially prepared or natural cores by plant roots was devised.
3. Sudangrass roots penetrated compacted cores more readily than did soybean roots.
4. Pooling all soils for each crop, a highly significant negative correlation was found between bulk density and penetrating root weight for both soybeans and sudangrass.
5. Bulk densities that virtually excluded root penetration were obtained at values of 1.8 with the Hagerstown (18 to 21 inches and 24 to 27 inches) and Shirley (18 to 21 inches) soil materials, at a value of 2.0 with the Hublersburg (12 to 15 inches) soil material.

J. Series Paper No. 2476, Pa. Agr. Expt. Sta., University Park, Pa.

Williams, R. J. B., and Cooke, G. W. SOME EFFECTS OF FARMYARD MANURE AND OF GRASS RESIDUES ON SOIL STRUCTURE. Soil Sci, 92: 30-39. 1961.

Clay and sandy soils that had contrasted continuous treatments were used in laboratory measurements of pore sizes, of aggregate stability and permeability, and of clod strengths.

Thin sections showed close packing occurred in natural aggregates of sandy soils under continuous arable cultivation; sands improved by farmyard manure (FYM) or by grass roots; and all the clay soils tested had some large pores. Pore-size measurements showed that checks to root growth were unlikely with the clays used but were possible with the arable sands.

A simple and quick practical test was developed to identify soils where unstable structure may lead to poor crops. The percentage loss in pore space that occurred after twice wetting and draining an aggregated soil sample measured structural instability such as may lead to close packing in wet weather; the rate water passed through soil after the slaking test measured permeability and indicated whether trouble may be expected from small pores in packed soil.

Continuous grass was more effective than annual dressings of FYM in making soils more permeable, in making aggregates stable to water, and in weakening clods formed by mechanical ill-treatment. Sandy soil under continuous arable cultivation without FYM gave very unstable aggregates and packed badly after slaking, but FYM given once in 5 years improved stability and permeability only slightly. Six months after sowing grass, the sandy soil was much more stable but still packed badly; 3 years under grass stabilized structure completely, but most of the improvement was lost a year after plowing.

For high yields of arable crops on soils that are unstable and poorly permeable, more organic matter may be needed than is given by the residues of arable crops grown on the land; the extra organic matter is better provided by a period under grass than by occasional dressings of FYM.

Rothamsted Expt. Sta., Harpenden, Herts., England.

In 1950, an experiment was inaugurated in Russia on the melioration of solonetzes by the application of gypsum and by the biological method of planting shrubs.

Information describing the changes that occurred under the influence of the shrubs in certain properties of the solonetzes that had not been treated with gypsum is given. The meliorating action of *Tamarix*, sumac (*Cotinus*), *Elaegnus*, the yellow acacia, Tatar maple, and box-elder was studied. The shrubs were planted in 1952. From 1953-58 the growth and development of the shrubs and the soil processes were observed. The authors concluded:

1. Many shrubs are tolerant of the solonet and solonchak properties of the soil and develop satisfactorily on solonetzes and substantially improve their properties.
2. Owing to the secretions from living shrubs roots and the decomposition of litter with a high calcium content, the soil is desolonetized and enriched in nutrients and the biological activity of the solonetzes is increased.
3. Owing to their thick root system, shrubs have an important meliorative effect on solonetzes, by loosening the soil and thereby changing its physical properties (decreasing compactness, improving porosity, and sharply increasing water intake). The degree in which the shrubs affect the soil depends on their species and age.
4. Water permeability and water intake in solonetzes under shrubs are two to three times greater than in virgin and plowed solonetzes; this means that almost all the rain and thaw waters can be absorbed by the soil.
5. Owing to the better water-permeability of solonetzes under shrub and the greater snow-retention of shrubs plantings, the wetting depth in spring increases to 150-200 cm, or more, against 30-40 cm, in virgin solonetzes, with the result that the soil moisture contents under shrubs are considerably greater.
6. The larger soil moisture contents and greater wetting depth modifies soil formation by improving leaching and promoting desalinization.
7. The changes in the physical and chemical properties and regimes of solonetzes under the influence of shrubs make for improved agricultural meliorative and forest growth properties and for higher fertility.

Amer. Inst. Biol. Sci., 2000 P St, N.W., Washington 6, D.C.

Rangaswami, G., and Ramalingam, M. THE INFLUENCE OF MICROORGANISMS IN SOIL AGGREGATION. J. Indian Soc. Soil Sci. 9: 193-195. 1961.

Aspergillus sp., Streptomyces sp., and Bacillus mycoides, isolated from soil, were tested for their effect on aggregating soil particles, using a clayey soil. It was found that all the three organisms had a binding effect on the soil particles, the percentage increase in aggregation ranged from 13 to 21. Of the three organisms, B. mycoides was found to be the best in this regard. When mixed cultures of the organisms were added to the soil, there were slight reductions in the aggregation, but these were not due to inhibitory action of the organisms on each other.

Annamalai U., South Arcot, Madras, India.

Good stable soil structure is valuable for promoting the growth of plants and micro-organisms by permitting enhanced aeration and water penetration, and by decreasing erosion under some conditions.

Micro-organisms influence water percolation through the soil. They may plug up soil pores with byproducts of growth and reduce water percolation. On the other hand, if a soil containing a large amount of microbial products is stirred and allowed to dry, then the percolation may be high.

Micro-organisms are involved in stabilizing soil structure by their products of decomposition and their cellular binding material, such as mycelia. Micro-organisms differ greatly in their ability to stabilize soil structure. Restricting the micro-flora to superior soil structure stabilizing micro-organisms materially increases soil structure stability. This restriction is accomplished under laboratory conditions by first eliminating the indigenous soil flora and then introducing the desired micro-organisms. Indigenous flora can be eliminated by autoclaving or by the use of a soil fumigant such as chloropicrin. Some fumigants, such as urea-formaldehyde and biuret-urea-formaldehyde at certain critical concentrations, selectively eliminate soil micro-organisms, leaving only effective soil aggregators. Physical and chemical factors, such as temperature, moisture, and amount and nature of energy material, affect the growth and effectiveness of soil structure stabilizing micro-organisms.

The use of superior micro-organisms for changing nutrient availability, nitrogen fixation, and soil structure stabilization may permit a degree of control over plant growth which heretofore has been impossible.

U. Mo., Agr. Expt. Sta., Columbia, Mo. (Author-SWCRD, ARS, USDA, Lincoln, Nebr.)

Holt, R. F., Blake, G. R., Voorhees, W. B., Boelter, D. H., and Robertson, A. S. SOIL MOISTURE SURVEY OF SOME REPRESENTATIVE MINNESOTA SOILS. U.S. Dept. Agr., Agr. Res. Serv., ARS 41-48, 43 pp. 1961.

A survey of the water holding characteristics of some major soil types of Minnesota was made. Soils selected for survey were restricted primarily to the western edge of the State.

The soils chosen for investigation represent the Chernozem, Prairie, Degraded Chernozem, Gray-Brown Podzolic, and Humic Gley great soil groups. An attempt was made to choose soils representative of rather broad areas so as to make the information obtained applicable to as large an area as possible.

The soils have been largely selected from farms operated by Soil Conservation District cooperators and represent a high level of soil management.

A total of nineteen soils was studied. The table lists these soils according to sample number, soil type, location, soil group, and total and available inches of water to 5 feet.

TABLE.--Total water holding capacity and available water in Minnesota soils

Sample No.	Soil Type	County	Great Soil Group	Total Inches of Water to 5 Feet	Available Inches of Water to 5 Feet
1.	Aastad silty clay loam	Chippewa	Chernozem	23.99	13.63
2.	Aastad clay loam	Lyon	Chernozem	22.30	12.15

TABLE.--Total water holding capacity and available water in Minnesota soils--Continued

Sample No.	Soil Type	County	Great Soil Group	Total Inches of Water to 5 Feet	Available Inches of Water to 5 Feet
3.	Barnes loam	Otter Tail	Chernozem	23.22	12.47
4.	Barnes clay loam	Chippewa	Chernozem	24.46	12.72
5.	Barnes clay loam	Lyon	Chernozem	21.52	11.46
6.	Bearden silt loam	Wilkin	Chernozem	25.30	13.65
7.	Dickinson sandy loam	Redwood	Prairie	7.30	3.94
8.	Fargo silty clay	Wilkin	Humic Gley	31.28	13.37
9.	Fayette silt loam	Wabasha	Gray-Brown Podzolic	22.99	14.37
10.	Kranzburg silt loam	Pipestone	Chernozem	24.34	13.93
11.	Moody silt loam	Rock	Chernozem	22.33	13.30
12.	Mora silt loam	Mille Lacs	Gray-Brown Podzolic	13.38	9.06
13.	Nicollet clay loam	Sibley	Prairie	22.39	10.84
14.	Nicollet clay loam	Watonwan	Prairie	21.42	11.86
15.	Rothsay silt loam	Lac qui Parle	Chernozem	19.57	12.29
16.	Rothsay silt loam	Lac qui Parle	Chernozem	19.02	10.66
17.	Vienna silty clay loam	Nobles	Chernozem	22.46	12.28
18.	Waukon silt loam	Otter Tail	Degraded Chernozem	21.68	11.07
19.	Waukon clay loam	Otter Tail	Degraded Chernozem	17.64	9.74

Soil profile descriptions for each soil investigated, together with moisture release data, particle size distribution, bulk density and total and available inches of water, appear in tabular form.

Tables and map.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hamon, W. R. ESTIMATING POTENTIAL EVAPOTRANSPIRATION. J. Hydraul. Div., ASCE 87 (HY 3): 107-120. May 1961.

Methods of computing potential evapotranspiration by analytical procedures have been based on the application of the turbulent-transport and energy-balance concepts. Empirical formulas, correlating some temperature function and adjusting for day-time hours, have proved valuable in practical utilization. This latter approach was used to formulate a simple computational procedure whereby average daily potential evapotranspiration is represented as proportional to the product of day-time hours squared and the saturated water vapor concentration (absolute humidity) at the mean temperature. The day-time factor was determined from a consideration of the disparity between net radiation and temperature, latitudinally, and the fact that transpiration is restricted during darkness since the leaf stomata are closed.

Computed values of potential evapotranspiration obtained by the new procedure are compared with those obtained by the more complex Thornthwaite method and other methods currently employed. General applicability seems justified from comparisons between observed and computed values of potential evapotranspiration, both on a yearly and seasonal basis.

The Travelers Res. Cent., Inc., Hartford, Conn.

Scholte Ubina, D. W. SOLAR AND NET RADIATION, AVAILABLE ENERGY AND ITS INFLUENCE ON EVAPOTRANSPIRATION FROM GRASS. *Netherlands J. Agr. Sci.* 9: 81-94. 1961.

From studies on radiation and energy balance in the Netherlands, it is concluded that reliable values for the net radiation over 24 hour periods can be obtained by computation, if differences in weather conditions during daytime and night are taken into account. A comparison of measured net radiation above short grass with net radiation computed from air temperature, water vapor pressure in the air, and sunshine duration is given. Variations in nature of a cropped surface, as a consequence of variations in conditions of such a surface, may have influence on the radiation and energy balance. However, if soil moisture becomes less available for plant roots, moisture content is much more important for the distribution of the available energy over heating the soil, the air, and over evapotranspiration than the type and nature of the soil cover.

For daily and 24-hour periods with similar atmospheric conditions, a linear relation between total global radiation and net radiation can be expected.

The ratio evapotranspiration from short grass under optimal water supply over the evaporation from a wet surface (or thin water layer) varied greatly for short periods of time under different conditions of radiation and temperature. These variations could be due to plant or weather factors influencing the aperture of the stomates, although variations in stability of the lower air layers may have had some influence.

Some differences between the evapotranspiration from grass under radiant and under "advective heat" supplies are discussed. Variations in intensity of potential and of maximum evapotranspiration rates and differences in the diurnal variations, as compared with the diurnal variation of net radiation, are shown.

A decrease of actual evapotranspiration from crops as soil moisture becomes less available and the potential evapotranspiration rate strongly depend on the net radiation gain.

Lab. Physics and Meteorology, Agr. U., Wageningen, Netherlands.

Marlatt, W. E., Havens, A. V., Willits, N. A., and Brill, G. D. A COMPARISON OF COMPUTED AND MEASURED SOIL MOISTURE UNDER SNAP BEANS. *J. Geophysical Res.* 66: 535-541. 1961.

Daily changes in soil moisture under snap beans were computed on a daily basis by the Thornthwaite equation, with various adjustments to account for decreasing water loss with increasing water deficit. These values are compared with data obtained by extensive gravimetric sampling. Statistical analysis indicates that when moisture tensions over the rooting zone are less than 1 atmosphere, actual evapotranspiration is essentially equal to potential evapotranspiration but that it falls sharply when tensions exceed this limit. The accuracy and practical feasibility of water balance computations on a short-term basis are emphasized.

N. S. State Expt. Sta., New Brunswick, N.J.

Bahrani, B., and Taylor, S. A. INFLUENCE OF SOIL MOISTURE POTENTIAL AND EVAPORATIVE DEMAND ON THE ACTUAL EVAPOTRANSPIRATION FROM AN ALFALFA FIELD. *Agron. J.* 53: 233-237. 1961.

The neutron scattering method was used for measuring soil moisture content at different times, from which the actual rate of evapotranspiration of alfalfa plots receiving different irrigation treatments was calculated. Tensiometers and plaster-resistance blocks were used to measure the moisture potential in the root zone. The net radiation intensity over the crop was measured by the use of an economical net radiometer.

The amount of water used for the month of July decreased with increase in the mean integrated moisture potential in the root zone of the different plots. The actual evapotranspiration and its ratio to "potential evapotranspiration" (calculated by Penman formula) showed a curvilinear relation with the average moisture potential.

There was a large reduction in net radiation over the field after the crop was removed. This was accompanied by a decrease in evapotranspiration and an increase in soil temperature. After irrigating the bare soil, net radiation and evapotranspiration increased and soil temperature decreased. The soil temperature near the surface of moist plots was found to be lower than that of drier plots at all times. The dry matter production of alfalfa decreased with decrease in mean integrated moisture potential.

Jr. Author, Utah State U., Logan, Utah.

Kemper, W. D., Robinson, C. W., and Golus, H. M. GROWTH RATES OF BARLEY AND CORN AS AFFECTED BY CHANGES IN SOIL MOISTURE STRESS. *Soil Sci.* 91: 332-338. 1961.

The retarding effect of temporary moisture stress on growth rate was partly compensated by a rapid growth rate following a release of this moisture stress. The rapid growth rate following release of soil moisture stress is tentatively attributed to increased turgor pressure in the cells and an accumulation of simple sugars during the previous period of large stress. This growth rate decreased by more than 50 percent from its maximum value within 4 days of the time when moisture stress was released. This decrease is attributed to lowered turgor pressure and carbohydrate availability, caused by a depletion of sugar content to normal levels and a deficiency of other materials, necessary for growth, caused by the previous period of rapid growth.

This phenomenon was noted in alfalfa, barley, and corn.

There was a strong indication that larger stresses caused by higher salt content in the soil delayed the maturity of corn.

SWCRD, ARS, USDA, Fort Collins, Colo.

Blaney, H. F. CONSUMPTIVE USE AND WATER WASTE BY PHREATOPHYTES. *J. Irrig. and Drain. Div. ASCE* 87 (IR 3): 37-46. Sept. 1961.

Phreatophytes are vigorous, water-loving plants ranging from small natural vegetation to large saltcedar (tamarisk) and cottonwood trees. These plants habitually obtain their water supply from the zone of saturation, either directly or through the capillary fringe in areas of high ground water. Although phreatophytes occur in all regions of the United States, they are the greatest menace in the areas of limited water supplies in the Southwestern States, where they occupy large areas along stream and river channels, on flood plains, and

in areas of high water table. These plants are spreading rapidly, and are consuming and wasting large quantities of water that could be put to beneficial use for irrigation, domestic, and industrial purposes. Dense growth of phreatophytes causes accumulation of sediment, blocks river channels, and increases flood hazards. Studies of consumptive use (evapo-transpiration) indicate that saltcedar and cottonwoods use from 50% to 100% more water than most agricultural crops. Estimates indicate that phreatophytes cover about 16 million acres in the western half of the United States, and consume nearly 25 million acre-ft of water annually. Preliminary studies in California and New Mexico indicate that about 25% to 50% of consumptive use and waste by these water-loving plants may be saved for beneficial uses by elimination of saltcedar and cottonwoods.

Results of measurements of consumptive use by phreatophytes are presented; a method of estimating rates of water consumption for areas in which no measurements are available is described.

Measurements of consumptive use and estimates of consumptive use and estimates of consumptive waste that might be salvaged for beneficial use are presented.

SWCRD, ARS, USDA, Los Angeles, Calif.

Roberts, W. J. REDUCTION OF TRANSPERSION. *J. Geophysical Res.* 66: 3309-3312. 1961.

The monomolecular film technique for reducing evaporation from water surfaces has been applied to the problem of transpiration from plants. Hybrid corn growth in soil enriched by various amounts of fatty alcohols such as hexadecanol has required up to 40 percent less water during its growth than control plants. It is theorized that some of the transpiration from corn plants can safely be reduced by the blocking action of molecules of hexadecanol carried through plants and deposited at the stomate water-vapor interface. Although the blocking action could be taking place throughout the plants, testing with C<sup>14</sup> hexadecanol has produced radioautographs showing activity not only in the roots and stalks but also throughout the leaves of treated corn plants. Comparative testing has been done in the greenhouse. Chemical tests on this corn showed no apparent effect of large doses of hexadecanol added to the roots of the plants.

State Water Survey Div., Urbana, Ill.

King, L. G., and Schleusener, R. A. FURTHER EVIDENCE OF HYSTERESIS AS A FACTOR IN THE EVAPORATION FROM SOILS. *J. Geophysical Res.* 66: 4187-4191. 1961.

Evaporation studies were conducted on a fine sand, which was in contact with a water table and was subjected to diurnal cyclic atmospheric conditions. Previous studies under steady atmospheric conditions showed that an inverse relation between the rate of evaporation from soils and the rate of evaporation from a free-water surface occurred under certain conditions. These studies also showed that this inverse relationship was produced by decreased evaporativity as the depth to the water table was increased. A theoretical explanation of this phenomenon was presented on the basis of a hysteresis in the functional relation between permeability and saturation of soils. The data show that this phenomenon also occurs under cyclic atmospheric conditions. It was concluded that the inverse relationship could occur in soils under field conditions, and could be a significant consideration in predicting evaporation from soils.

Colo. State U., Fort Collins, Colo.

The comparison of the soil moisture regimen in lysimeters with that on adjacent watersheds has hydrologic implications that have an important bearing on soil and water conservation research. The problem of water yields is a common one in the field of soil conservation. How can we best obtain information on water yields? Can it be supplied from data obtained on small plots and applied to larger areas by use of an area factor? The data indicate the extrapolation from small areas to larger ones is not that simple. Such factors as soil profile characteristics, position and elevation of the slope, soil moisture levels, and the possibility of lateral flow must be considered in making these extrapolations.

Soil moisture regimen in lysimeters is not always the same as that on small watersheds. The extent of deviation varies with soil type and with moisture content. The regimen on a well-drained soil, such as the Muskingum sil, more nearly approaches that of the watershed than it does on a soil with impeding layers in the profile, such as the Keene sil. Lateral flow on the watershed may account for much of the deviation. In accounting for disposal of precipitation the lysimeter gave a more adequate opportunity for checking than the watershed did, but the disposal indicated may not be the natural one.

ARS, USDA, Inform. Div. Washington 25, D.C.

McGuinness, J. L., Dreibelbis, F. R., and Harrold, L. L. SOIL MOISTURE MEASUREMENTS WITH THE NEUTRON METHOD SUPPLEMENT WEIGHING LYSIMETERS. Soil Sci. Soc. Amer. Proc. 25: 339-342. 1961.

Evaluation of soil moisture changes with the neutron method agreed closely with that obtained from the weighing lysimeters. Evapotranspiration can be determined with either method by equation.

$$ET = P - G - Q \pm \Delta M$$

where  $ET$  = evapotranspiration,  $P$  = precipitation,  $G$  = percolation,  $Q$  = surface runoff and  $\Delta M$  = change in soil moisture.

Differences were shown in the soil moisture extraction pattern under deep-rooted and shallow-rooted meadow crops. The hydrologic implications of this difference are discussed.

SWCRD, ARS, USDA, Coshocton, Ohio.

Van Bavel, C. H. M., Nielson, D. R., and Davidson, J. M. CALIBRATION AND CHARACTERISTICS OF TWO NEUTRON MOISTURE PROBES. Soil Sci. Soc. Amer. Proc. 25: 329-334. 1961.

The effect of the size of cylindrical containers filled with soil on the calibration of two types of neutron probes was investigated for moisture contents up to 0.25 volume fraction. Neutron count rates were appreciably affected by the value of both diameter and height up to 3 feet. Differences between 3 and 4 feet were small.

The response of the end-source probe was linear within the range investigated (0 to 0.40 volume fraction). The data show that the end-source probe design as compared with the centered-source design is more efficient and requires a smaller radioactive source for equal precision.

Once an accurate calibration with soil is available, verifying calibration of probes may be done with NaCl or H<sub>3</sub>BO<sub>3</sub> solutions, limited to probes of identical design but differing efficiencies or source strengths. Relations found between soil moisture content and solution concentration are given.

A discussion of the range of measurement of soil moisture content with neutron probes is presented, comparing various literature data.

SWCRD, ARS, USDA, Tempe, Ariz.

Bower, H. A DOUBLE TUBE METHOD FOR MEASURING HYDRAULIC CONDUCTIVITY OF SOIL *IN SITU* ABOVE A WATER TABLE. *Soil Sci. Soc. Amer. Proc.* 25: 334-339. 1961.

A method for measuring hydraulic conductivity of soil *in situ* above a water table is proposed. The method consists essentially of saturating a limited soil region below an auger hole in which two concentric tubes are placed. Hydraulic conductivity is calculated from measurements of the rate of change of the water level in the inner tube. The procedure is based on separating the flow between the tubes due to different water levels in the tubes from the total flow, which includes continued intake of water by the soil. Dimensionless parameters describing the flow component due to different water levels in the tubes are used in the calculation of the conductivity. These parameters were determined with a resistance network analog for three soil conditions, a uniform soil, a soil underlain by material of much lower conductivity, and a soil underlain by material of much higher conductivity. The depth to the material of different conductivity was taken as a variable. The method is illustrated with an example.

SWCRD, ARS, USDA, Tempe, Ariz.

Letey, J., Lunt, O. R., Stolzy, L. H., and Szuszkiewicz. PLANT GROWTH, WATER USE AND NUTRITIONAL RESPONSE TO RHIZOSPHERE DIFFERENTIALS OF OXYGEN CONCENTRATION. *Soil Sci. Soc. Amer. Proc.* 25: 183-186. 1961.

Various oxygen level treatments were applied to snapdragons grown in cylinders by varying the oxygen concentration above the soil surface. Other soil physical properties were held relatively uniform during the experiment. The aerial portions, except for part of the stem, were isolated from the rhizosphere treatments. Eight treatments ranging from <1% to 21% O<sub>2</sub> were applied. In general, plant growth increased with higher oxygen levels. The relative content of phosphorus and potassium in shoots increased with increasing oxygen concentration. Sodium content increased with decreasing oxygen and showed a very marked increase at the lowest oxygen levels. Water use decreased with decreasing oxygen.

U. Calif. Agr. Expt. Sta., Los Angeles, Calif.

Burns, A. F., and Barber, S. A. THE EFFECT OF TEMPERATURE AND MOISTURE ON EXCHANGEABLE POTASSIUM. *Soil Sci. Soc. Amer. Proc.* 25: 349-352. 1961.

The influence of temperature and moisture on the release of nonexchangeable K to the exchangeable form was studied in the laboratory. Varying moisture from 60 to 100 percent of moisture equivalent was found to have no effect on the release of nonexchangeable K in all but one case. The higher the temperature, the greater was the rate of release of nonexchangeable K.

The first release of K appeared to conform to a first-order reaction, while subsequent release was of a zero-order nature. Activation energies were determined from data obtained by the incubation of soils at three temperatures. These values were in the range of 11,000 to 26,000 cal. per mole.

Data obtained by oven-drying soils before and after incubation at 118° C. indicate that the increases in exchangeable K obtained by these two methods were due to different reactions.

J. Paper 1692, Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Thames, J. L., and McReynolds, R. D. A HYDRAULIC SOIL SAMPLER. *Agr. Engin.* 42: 431-432. 1961.

A portable hydraulic sampler for taking undisturbed soil cores on refractory sites is described and illustrated. It was tested in north Mississippi and found to work well in a variety of soils including loose sand and heavy clay as well as cemented Coastal Plain parent material. The fractured cores common with hand-held rotary samplers and shattered or compressed cores common with drive samplers were eliminated.

Steady hydraulic pressures up to 5,000 lb. per square inch minimize soil disturbance by forcing the cutting edges of a sampling head slowly into the soil.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Buchele, W. F. A POWER SAMPLER OF UNDISTURBED SOILS. *Trans. ASAE.* 4: 185-187, 191. 1961.

An undisturbed column of soil is required to measure the physical properties of soil and the distribution of roots, insects, and fertilizer within the soil. Because of the excessive expense of digging a trench around an undisturbed soil column, research on the physical properties etc. of soil in the undisturbed state has been limited.

An undisturbed soil column power sampler was designed and developed to pull columns of soil 36 inches in length. Stress on the soil column was held to the minimum by using a floating soil tube inside an open centered auger. The position of the tube with respect to the auger was dependent upon the hardness of the soil.

Soil depth profile graphs were plotted from measurement data gain by the processing of sectioned undisturbed soil columns.

Mich. State U., East Lansing, Mich.

Metz, L. J., Lotti, T., and Klawitter, R. A. SOME EFFECTS OF PRESCRIBED BURNING ON COASTAL PLAIN FOREST SOIL. *Southeastern Forest Expt. Sta., Sta. Paper 133,* 10 pp. 1961.

A study was made from 1946 to 1956 of the effect of prescribed burning on soils beneath loblolly pine stands growing in the level, lower coastal plain of the Southeastern United States. Data were collected on two experimental areas located about 30 miles apart in South Carolina. The sites are comparable in that they have similar topography and surface soil texture. Annual and periodic fires over a 10-year period had no significant influence on the physical properties of the soil. Mineral elements, nitrogen, and organic matter tended to increase in the surface 4 inches of the burned plots.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

## Soil Chemistry and Minerology

Schofield, R. K., and Taylor, A. W. A METHOD FOR THE MEASUREMENT OF THE CALCIUM DEFICIT IN SALINE SOILS. *J. Soil Sci.* 12: 269-275. 1961.

The calcium deficit of a saline soil is defined as the amount of calcium which must be supplied to saturate the soil with divalent cations. A method is described whereby this amount can be measured in samples of unwashed saline soil and used to estimate the amount of gypsum needed in the field to prevent deterioration of the soil structure while it is being leached into a salt-free condition.

Rothamsted Expt. Sta., Harpenden, Herts., England.

Lucas, R. E., and Davis, J. F. RELATIONSHIPS BETWEEN pH VALUES OF ORGANIC SOILS AND AVAILABILITIES OF 12 PLANT NUTRIENTS. *Soil Sci.* 92: 177-181. 1961.

A chart that shows the relationship of pH to the availability of 12 essential plant nutrients in organic soils is presented. In general, the ideal pH falls in the range of 5.5 to 5.8 for wood-sedge organic soils and pH 5.0 for sphagnum peats. This range is 1 to 1.5 pH units lower than that generally considered to be most desirable for mineral soils. At these pH's ample calcium is available to plants because of the high exchange capacity of organic soils and the high availability of replaceable calcium. Liming organic soils above pH 5.8 is objectionable because of reduced phosphorous, manganese, boron, and zinc availability.

Very acid organic soils show low availability of many elements, chiefly because of low natural mineral content. Potassium, calcium, nitrogen, boron, copper, and molybdenum are elements commonly found to be deficient in very acid soils.

Mich. State U., East Lansing, Mich.

Mandal, L. N. TRANSFORMATION OF IRON AND MANGANESE IN WATER LOGGED RICE SOILS. *Soil Sci.* 91: 121-126. 1961.

Rice plants were grown in water-logged soil in large pots with and without the addition of organic matter. At periodic intervals, samples of drainage water and of soils were collected. The drainage water was analyzed for dissolved  $\text{CO}_2$  soluble  $\text{Fe}^{++}$  and  $\text{Mn}^{++}$ , and the soil for exchangeable  $\text{Fe}^{++}$  and  $\text{Mn}^{++}$ , insoluble  $\text{Fe}^{++}$ , and  $\text{Fe}$  sulfide. The results with control soil showed a sharp rise of insoluble ferrous iron with water-logging of soil. Later, with an increase in  $\text{CO}_2$  concentration in the soil solution,  $\text{Fe}^{++}$  entered into the exchangeable complex; and still later, with further increase of  $\text{CO}_2$ , it appeared in the drainage water in soluble form. In the presence of organic matter, the reduction process was more intensive and  $\text{CO}_2$  production greater. Under such conditions all three fractions (insoluble, exchangeable, and soluble  $\text{Fe}^{++}$ ) were recorded much earlier, and were present in much larger quantities than those in the control soil.

The course of transformation of manganese was somewhat different from that of iron. It entered into the exchangeable complex and also appeared in soluble form much earlier than iron. The reducible manganese, comprising higher oxides, such as  $\text{MnO}_2$ ,  $\text{Mn}_2\text{O}_3$ ,  $\text{Mn}_3\text{O}_4$ , showed a decrease for some time after the soil had been water-logged and then began to increase to a level that was higher than that at the start.

Since iron and manganese in organic complex did not show significant changes in any treatment, this fraction is evidently not affected to any appreciable extent by the conditions of water-logging with or without the addition of organic matter.

State Agr. Res. Inst., West Bengal, India.

An experiment testing 5 rates each of nitrogen, phosphorus, and potash and 2 rates of lime on corn and peanuts grown in rotation on Red Bay fsl was sampled annually for 8 years.

A ton of dolomitic lime increased the exchangeable calcium approximately 200 pounds per acre. Cropping with a 2-year rotation of corn and peanuts used up this much in about 5 years.

Three tons of dolomitic lime were required to raise the pH from 5.2 to 6.2. Organic matter was maintained at approximately 3% over the 8-year period. When potash was applied at rates of 30, 60, and 120 pounds per acre of K<sub>2</sub>O annually, 20 to 35% of it could not be accounted for in the top 36 inches after 4 years. The exchangeable potash in the surface 6 inches fluctuated with the annual rainfall.

Fertilizer phosphorus remained in the surface 6 inches. Fractionation studies showed that it was converted to free aluminum and iron phosphates in the ratio 2 to 1. In the 8-year period occluded and reductant forms of aluminum and iron phosphates were relative constant. When cropped without additional phosphorus, the aluminum phosphorus decreased while the iron phosphorus was constant.

Fla. Agr. Expt. Sta., Gainesville, Fla.

North Central Mineral Deficiencies Committee. NORTH CENTRAL REGIONAL POTASSIUM STUDIES: II. GREENHOUSE EXPERIMENTS WITH MILLET. *Purdue U. Agr. Expt. Sta. Res. B.* 717, 19 pp. 1961.

Three experiments were conducted with soils collected from field experiments investigating the response to potassium in the north-central region. Results indicated that: (1) Exchangeable potassium on a field moist sample was a reliable measure of potassium availability on north-central soils when availability was measured on field-moist soil. (2) Percent yield, percent potassium, and yield of potassium were about equally effective estimates of the availability of potassium in the soil to the plant. However, percent yield provided a measure only on soils with an exchangeable potassium content below 200 p.p.m. (3) Drying the soil, particularly the 18- to 24-inch samples, usually increased the exchangeable potassium and the potassium available to the plant. (4) The correlation was the highest where the exchangeable potassium and the available potassium were both determined on soil in the same moisture condition. And (5) the uptake of non-exchangeable potassium and the fixation of potassium by the soil varied from soil to soil and did not appear to be related to any of the properties which were measured.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Nolan, C. N., and Pritchett, W. L. CERTAIN FACTORS AFFECTING THE LEACHING OF POTASSIUM FROM SANDY SOILS. *Soil and Crop Sci. Fla. Proc.* 20: 139-145. 1960.

A series of experiments was conducted in large lysimeters, in the greenhouse and in the laboratory to study certain factors related to leaching of potassium from mineral soils. The following variables were investigated and their relationship to potassium leaching discussed: Soil cover, rates and methods of application of potassium fertilizers, leaching intensity, and soil reaction.

Crops growing on the soil reduced the leaching losses of potassium in outdoor and greenhouse experiments. This reduction in leaching losses of potassium by plants was affected through a reduction in the amount of gravitational water passing through the soil and by absorption of fertilizer potassium into the plant tissues.

The type of crop or root systems of crops greatly affected the leaching of potassium. A combined oat and millet crop reduced the leaching of potassium from an application of 480 pounds of K<sub>2</sub>O per acre by 46.3% when compared with potassium leached from the same rate of KC1 on cabbage and sweet potato crops.

Potassium losses from Arrendondo fs increased with each increment of KC1 added to cropped and fallow soils. Potassium leaching losses were greater from band placement of KC1 than from a broadcast application on sweet potato crops.

Soil reaction significantly influenced the amounts of potassium retained in Lakeland fs in a laboratory study. The average leaching losses of potassium at pH 4.2 were 1-3/4 times greater than at pH 5.3 and 2-3/4 times greater than at pH 6.3. The amounts of potassium lost from Red Bay Ifs were relatively small, even at low pH levels. The influence of pH on potassium losses from this soil was similar to that observed with Lakeland s. The reduction in potassium losses in soils limed to near neutrality is probably due to: (1) An easier substitution of potassium for calcium than for hydrogen or aluminum on the exchange complex; and (2) an increase in the effective exchange capacity of the soil.

Data obtained from these experiments indicate that the following practices would be advantageous for the conservation of potassium in Florida soils: (1) a cover crop should be maintained on the soil whenever possible; (2) relatively small amounts of potassium salts should be applied at each application; (3) where large amounts of potassium salts are added in single applications, they should be applied broadcast rather than by band placement, and (4) the soil pH should be maintained from 6.0 to 6.5 through proper liming practices.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Haas, H. J., Grunes, D. L., and Reichman, G. A. PHOSPHORUS CHANGES IN GREAT PLAINS SOILS AS INFLUENCED BY CROPPING AND MANURE APPLICATIONS. Soil Sci. Soc. Amer. Proc. 25: 214-218. 1961.

Soil samples from 15 dryland experiment stations in the U.S. Great Plains and 21 farms in North Dakota were analyzed to determine the effect of cropping and manure on total, inorganic, organic, and NaHCO<sub>3</sub>-soluble P content. In general, total P in the surface 6 inches of soil increased from south to north. Total P in soils from the experiment stations was reduced an average of 8% by cropping without manure, but was increased an average of 14% above virgin sod where manure had been applied.

Inorganic P was not influenced by cropping to a rotation without manure, but organic P was reduced an average of 35% as compared to virgin sod. Manure applied in the rotation increased inorganic P considerably, but had no effect on reducing the loss of organic P.

Cropping without manure increased NaHCO<sub>3</sub>-soluble P in the soil at the majority of the stations, with the greatest increase occurring in the South. When manure was applied in the rotation, NaHCO<sub>3</sub>-soluble P averaged nearly five times that of virgin sod.

A highly significant positive correlation existed between NaHCO<sub>3</sub>-soluble P and total P of virgin soils from the southern stations, but a significant correlation did not exist for the northern stations.

SWCRD, ARS, USDA, Mandan, N. Dak.

It was found experimentally that the added soluble phosphate in six soils, with pH ranging from 5.3 to 7.5, kept at field moisture capacity for 3 days is mainly fixed as aluminum phosphate, followed by iron phosphate and calcium phosphate. After keeping under the same conditions for 100 days, the amount of iron phosphate increases while that of the aluminum and calcium phosphate decreases. In two latosols the amount of iron phosphate surpasses that of aluminum phosphate. Under flooded conditions for 100 days, iron phosphate becomes the dominant form of phosphate fixed in all six soils. In a soil suspension, the soluble phosphate fixed in 3 hours is dominantly iron phosphate in five of the six soils.

It was also found that the superphosphate applied to a soil over 31 years is mostly retained in the form of iron phosphate, with aluminum phosphate next, and that least is retained as calcium phosphate. Liming did not significantly change the distribution pattern.

The data suggest that the first stage of fixation of the added soluble phosphate by the various cations would occur on the surface of the solid phases with which the phosphate comes in contact, and that the relative amounts and kinds of phosphates formed would depend on the specific surface area of the solid phases associated with aluminum, iron, and calcium. In time the aluminum and calcium phosphates then gradually change to the less soluble iron phosphate, the rate of transformation increasing with the moisture content of soil.

Col. Agr., National Taiwan U., Taipei, Taiwan, China.

Patel, J. M., and Mehta, B. V. SOIL PHOSPHORUS FRACTIONATION STUDIES. Soil Sci. Soc. Amer. Proc. 25: 190-192. 1961.

Total soil phosphorus in 21 soils was fractionated into 5 components, viz., (a) calcium phosphate, (b) adsorbed phosphate, (c) iron and aluminum phosphate, (d) organic phosphorus, and (e) phosphorus which is insoluble in the reagents that dissolve (a), (b), (c) and (d) fractions. It is found that none of these forms of soil phosphorus is a definite fraction of total phosphorus. The amount of the adsorbed phosphate gives the highest correlation ( $r = +0.8341$  significant at 1% level) with the uptake of phosphorus by sorghum plants. Also the amount of adsorbed phosphate gives a highly significant correlation ( $+0.9330$  significant at 1% level) with available phosphate determined by 0.5M  $\text{NaHCO}_3$ . There is also a correlation between the uptake of phosphate by sorghum plants and the amount of calcium phosphate, but the level of significance is much lower. There is no significant correlation between the plant uptake of phosphate and the amount of phosphorus in any one of the three remaining fractions, namely iron and aluminum phosphates, insoluble phosphate, and organic phosphorus.

Inst. Agr., Anand, India.

Wells, K. L., and Parks, W. L. VERTICAL DISTRIBUTION OF SOIL PHOSPHORUS AND POTASSIUM ON SEVERAL ESTABLISHED ALFALFA STANDS THAT RECEIVED VARIOUS RATES OF ANNUAL FERTILIZATION. Soil Sci. Soc. Amer. Proc. 25: 117-120. 1961.

Available soil phosphorus, potassium, calcium, and magnesium and pH were determined at various depths on four soil profiles under established stands of alfalfa. Three experiments were set up in a complete factorial design using four rates of annual phosphate application and five rates of annual potash application. The fourth experiment received five annual applications of potassium and no applications of phosphorus since it was on soil inherently high in phosphate.

Available potassium after 4 years of annual applications of potash on three soils and 5 years on one soil was concentrated in the 0- to 6-inch layer. Only a slight movement of potassium into depths below 6 inches was noted even at high rates of annual potash fertilization. Available soil phosphorus was found to be concentrated in the 0- to 3-inch layer. Annual potash and phosphate applications had little effect on soil reaction.

Significant difference in yield at the 0.05 level of probability was found between the 0- and the 100-pound-per-acre annual potash treatment in each experiment, and between the 0- and the 60-pound-per-acre annual phosphate treatment on those experiments receiving phosphate fertilization. No significant response to higher rates of annual topdressing was obtained.

Yield data were correlated with soil test potassium values of various soil layers. A poor correlation was found to exist between soil test potassium values and yield. Correlation values were increased by addition of phosphorus soil test values into the equation.

Jr. Author, U. Tenn., Knoxville, Tenn.

Laverty, J. C., and McLean, E. O. FACTORS AFFECTING YIELDS AND UPTAKE OF PHOSPHOROUS BY DIFFERENT CROPS: III. KINDS OF PHOSPHATE-NATIVE, APPLIED, AND FORMED. *Soc. Sci.* 91: 166-171. 1961.

The phosphate fractionation procedure of Chang and Jackson was used to study the fate of water-soluble P applied to various soils. Statistical analyses were made of the method as applied to a soil limed in the field to various pH levels. Least-significant-difference values were sufficiently low to reflect significantly the applied soluble phosphate in each of the fractions of the phosphate. Increase in "saloid-bound" phosphate due to phosphate treatment increased with pH of soil. Neither the treated nor the untreated samples showed any definite trend with soil pH in amount of "aluminum phosphate" present. As the pH of the soil increased a tendency for less phosphate in the "iron" phosphate fraction but more phosphate in the "calcium" phosphate fraction.

The phosphate fractionation procedure was applied to soils varying from 28 to 72 percent "fixation" of soluble phosphate against Bray #2 extract. The soils which fixed only 28 percent of the phosphate tied up 2-1/2 times as much phosphate in the "aluminum" as the "iron" phosphate fraction. At the other end of the range in fixation, nearly twice as much of the phosphate was found in the "iron" as in the "aluminum" phosphate fraction.

In another study, where the fractionation method was applied to soils treated with several different kinds of phosphate fertilizers and cropped, "iron," "aluminum," and "saloid-bound" phosphate fractions all appeared to be related to availability of P to oat seedlings. When mixed with the soil, special fertilizers, prepared with various combinations of  $\text{NH}_4\text{H}_2\text{PO}_4$  and  $\text{CaHPO}_4$ , showed an inverse relationship between water solubility of P and uptake of P by oats. Since the superphosphate was relatively high in water solubility but caused near maximum uptake of P, a difference between ammonium and calcium forms of phosphates in their fixation or lack of it by soil components is suggested.

The results suggest that this phosphate fractionation method may have merit as a tool in studying the fate of phosphate applied to soils.

J. Article 38-60, Ohio State U., Worster, Ohio.

Golden, L. E. AVAILABILITY OF NATIVE AND RADIOACTIVE FERTILIZER PHOSPHORUS TO OATS ON LAKE CHARLES CLAY. *Soil Sci.* 91: 349-355. 1961.

A study was made of the availability of native and fertilizer phosphorus in Lake Charles clay, with oats as the indicator crop.

The yields of oats as forage at different stages of growth and in grain at maturity were studied, and the total phosphorus content of the plants was determined at each of four harvests. The fertilizer phosphorus content of the plants was determined at the first three harvests by means of radioisotope techniques employing P-32 in fertilizer.

Different solutions were used as extractants for the removal of phosphorus from the soil.

A study was made of the approximate degree of phosphorus movement from the fertilizer band by estimating the radioactivity of soil samples.

Yields from the 12-12-12 banded and the 12-12-12 mixed treatments were significantly greater than yields from the 12-0-12 banded and the 12-0-12 mixed treatments, respectively, at all harvests. Forage yield from the 12-12-12 banded treatment, at each of the first three harvests, was significantly higher than forage yield from the 12-12-12 mixed treatment. There was no significant difference between grain yields from the 12-12-12 banded and the 12-12-12 mixed treatments. There was no significant difference between yields from the 12-0-12 banded and the 12-0-12 mixed treatments at either harvest period. It was concluded that phosphorus is needed in fertilizers for use on Lake Charles c soil, that band placement of a balanced fertilizer will produce higher forage yields than mixing the fertilizer with the soil, and that either mixing or banding fertilizer serves equally well for grain production.

The total phosphorus content of plants grown in soil receiving phosphorus treatment was higher throughout the experiment than that of plants grown in soil receiving no phosphorus. The initial difference in phosphorus content between plants receiving the 12-12-12 banded and the 12-12-12 mixed treatments had disappeared by the 8-week harvest. During the first 12 weeks, more fertilizer phosphorus was absorbed by plants receiving the 12-12-12 banded treatment than was absorbed by those receiving the 12-12-12 mixed treatment, but soil phosphorus was absorbed in larger quantities by plants receiving the 12-12-12-mixed treatment than was absorbed by the plants receiving the 12-12-12-banded treatment. It was concluded that phosphorus fertilization on Lake Charles c will cause phosphorus content of plants to be increased markedly. Band placements, as compared with mixing of fertilizer containing phosphorus with the soil, will account for higher phosphorus content of plants for only a few weeks, but it will effect a yield advantage for a longer period.

Phosphorus extracted from the soil by use of the 0.1 N HCl + 0.03 N NH<sub>4</sub>F solution more nearly characterized the phosphorus available to plants than did that from the 0.025 N HCl + 0.03 N NH<sub>4</sub>F or the 0.1 N HCl solutions.

Phosphorus movement from the band during the 12-week period following application was negligible. The high clay content of the soil and its high phosphorus-fixing capacity apparently accounted for the limitation on phosphorus movement.

La. Agr. Expt. Sta., University Sta., La.

Smika, D. E., Haas, H. J., Rogler, G. A., and Lorenz, R. J. CHEMICAL PROPERTIES AND MOISTURE EXTRACTION IN RANGELAND SOILS AS INFLUENCED BY NITROGEN FERTILIZATION. *J. Range Mangt.* 14: 213-216. 1961.

Ammonium nitrate was applied annually to native range plots during 9 years at rates of 0, 30, and 90 pounds of nitrogen per acre. At the end of this period, total soil nitrogen, available phosphorus, and pH determinations were made. During the last 6 years, spring and fall soil moisture determinations were made to evaluate the effect of fertilization on soil moisture withdrawal.

For the overall 6-foot depth, there was an increase in total soil nitrogen. Increases occurred in the first 2 depths under both the 30- and 90-pound treatments. Some decrease occurred in the 24- to 36-inch increment under both treatments. These decreases were possibly the result of increased root activity within these depths.

The increases in total soil nitrogen accounted for 88.9 percent and 69.1 percent of all the nitrogen applied in the 30- and 90-pound treatments, respectively, during the 9-year period. With the addition of the fertilizer nitrogen recovered in harvested herbage, a complete account of the 30-pound applications and 87.9 percent of the 90-pound applications was made.

In the 0- to 6-inch surface increment, soil acidity was increased 6.2 and 9.2 percent by the application of 30 and 90 pounds of ammonium nitrate nitrogen, respectively.

Phosphorus availability in the surface soil increased with increasing nitrogen rates. Increase in soil acidity was the determinant of the increased phosphorus availability. Less available phosphorus was present in the lower portion of the profile where nitrogen fertilizer had been applied. This was attributed to increased root activity in the lower depths.

Moisture withdrawal increased in all soil depths with the addition of nitrogen fertilizer. Greater moisture extraction accompanied greater fertilization rates. After 1957, there was little change in moisture withdrawal under any treatment. In the early years of the study, there were indications that fertilization stimulated root growth and moisture use in the subsoil.

SWCRD, ARS, USDA, Mandan, N. Dak.

Nelson, C. E. MOVEMENT OF  $\text{NH}_4^+$  AND  $\text{NO}_3^-$  NITROGEN FROM FIVE NITROGEN CARRIERS BANDED IN TWO ROW-TREATMENTS UNDER IRRIGATION. Wash. Agr. Expt. Sta., Sta. C. 380, 14 pp. 1961.

A study was made of the  $\text{NH}_4^+$ -N and  $\text{NO}_3^-$ -N movement in the soil under two different row treatments with controlled irrigation. Potatoes were grown to extract soil moisture.

In one treatment, rows were 34 inches apart and the soil was ridged around the plants. In the other treatment the rows were 26 inches apart with no ridging of the soil.

The nitrogen carriers used were urea, ammonium sulfate, ammonium nitrate, aqua ammonia, and calcium nitrate. These materials were banded 6 inches on both sides, and 3 inches below the seed pieces on June 4-5, about a month after the potatoes emerged. The result of subsequent ridging of the soil in the 34-inch row spacing was that the fertilizer band was level with the bottom of the irrigation furrow. In the 26-inch row spacing, without soil ridging, the fertilizer band was 3 inches lower than the bottom of the irrigation furrow.

The  $\text{NH}_4^+$ -N in the soil on June 17 from the ammonium carriers and urea was generally distributed between the two fertilizer band locations, 3 inches below and 3 inches towards the irrigation rills and extending to the soil surface. On July 16, the  $\text{NH}_4^+$ -N was greater in the ridged 34-inch row treatment than in the 26-inch row treatment with no soil ridging. For both treatments low  $\text{NH}_4^+$ -N concentrations occurred in zones 12 x 9 inches, 3 inches below the soil surface. Similar concentrations were observed on August 12.

The  $\text{NH}_3$ -N from all carriers moved towards the center between the irrigation rills and upwards into the soil surface. In the case of the ridged 34-inch row treatment, the movement of the  $\text{NO}_3^-$ -N upwards into the soil ridge resulted in much less downward movement with successive irrigations than in the 26-inch row treatment with no soil ridging.

No measurable pH changes resulted during the season from the treatments on this calcareous soil.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U, Pullman, Wash.

Meyer, R. D., Olson, R. A., and Rhoades, H. F. AMMONIA LOSSES FROM FERTILIZED NEBRASKA SOILS. Agron. J. 53: 241-244. 1961.

Losses of nitrogen as ammonia may result from the surface application of such fertilizers as urea, urea-ammonium nitrate solutions, ammonium sulfate, and ammonium nitrate. Such losses have been greater for urea-containing materials than from the other

nitrogen carriers studied. Losses are greatest on neutral to alkaline soils under conditions of limited rainfall, are magnified by presence of crop residue on the soil surface, and may be accentuated by cool temperatures which limit nitrification. In favorably moist soil, volatilization of the ammonia takes place rapidly in the first few days after application, tapering off to an insignificant rate in the second week.

It was concluded that urea compounds must be incorporated with the soil for insuring maximum efficiency of the materials unless rain or irrigation is assured immediately after surface broadcasting. Although ammonia volatilization with ammonium sulfate and ammonium nitrate does not approach that associated with urea materials it is of sufficient magnitude that mixing with soil should be advocated. Delaying application to the time when a crop is actively growing appears to be a logical recommendation for minimizing ammonia volatilization loss with all carriers.

Nebr. Agr. Expt. Sta., Lincoln, Nebr.

Schwartzbeck, R. A., MacGregor, J. M. and Schmidt, E. L. GASEOUS NITROGEN LOSSES FROM NITROGEN FERTILIZED SOILS MEASURED WITH INFRARED AND MASS SPECTROSCOPY. *Soil Sci. Soc. Amer. Proc.* 25: 186-189. 1961.

The evolution of nitrogen gases from four soils was studied by total soil nitrogen analysis, the mass spectrometer with  $N^{15}$ -labeled nitrogen carriers, and with infrared spectroscopy. The type and amount of nitrogen gas evolved was influenced by a number of factors. Soil type was important in that the Nicollet and Fargo soils resulted in the evolution of more  $N_2$  and  $N_2O$  than did the Fayette and Laredo soils. Soil properties had little effect on the total  $N_2$  evolved from  $NH_4NO_3$ , but greater differences occurred from soils treated with  $HNO_3$ . The type of nitrogen carrier influenced the nature of the gaseous nitrogen released.  $NH_4NO_3$  treatment favored  $N_2O$  evolution and  $HNO_3$  treatment favored  $N_2$ . Only small amounts of  $N_2$  and  $N_2O$  were evolved from soils treated with  $NH_4Cl$  or urea. Nitrogen applied at 1,080 pounds per acre always resulted in larger losses of  $N_2O$  and  $N_2$  than that applied at 360 pounds per acre. However, in both the Nicollet and Fargo soils at water saturation, the percentage of applied nitrogen that was lost was about the same at both low and high rates of treatment. Substantial gaseous losses of applied fertilizer occurred mainly when water-saturated conditions prevailed. Small losses did occur from soils at field moisture capacity.  $N_2O$  evolution was influenced by the ammonium to nitrate ratio of the nitrogen treatment.

*Sci. J. Series Paper 4439, Minn. Agr. Expt. Sta., U. Minn., St. Paul, Minn.*

### Soil Biology

Allison, F. E., and Klein, C. J. COMPARATIVE RATES OF DECOMPOSITION IN SOIL OF WOOD AND BARK PARTICLES OF SEVERAL SOFTWOOD SPECIES. *Soil Sci. Soc. Amer. Proc.* 25: 193-197. 1961.

The rates of decomposition of 10 kinds of finely ground woods and the corresponding barks at two nitrogen levels were determined in the laboratory by measuring  $CO_2$  evolution over periods varying from 53 to 800 days. The following species were studied: California incense cedar, cypress, redwood, western larch, eastern hemlock, red fir, white fir, Douglas-fir, red cedar, and Engelmann's spruce. The woods and barks of all of these species were considerably more resistant to biological attack than is short-leaf pine sawdust. California incense cedar, cypress, redwood, eastern hemlock, and red cedar were decomposed

to the extent of <7% during a 2-month period. The comparative resistance of woods and barks to decay varied for individual species but the average values for the 10 species were similar. Due to the slow rates of decomposition, the soil was able to furnish adequate available nitrogen for maximum rates of decomposition for all of the wood products, and supplemental nitrogen was not needed.

SWCRD, ARS, USDA, Beltsville, Md.

Rhee, J. A., Van, and Nathans, S. OBSERVATIONS ON EARTHWORM POPULATIONS IN ORCHARD SOILS. Netherland J. Agr. Sci. 9: 94-100. 1961.

Earthworm populations in connection with soil management was examined and the structure of the soil studied by evaluating the stability of aggregates. Use was made of three experimental fields in apple orchards used for soil management experiments. All sites consist of a fairly light soil with a silt content varying from 23% to 25%.

Only orchards with a grass cover afforded good facilities for the favorable development of earthworms. In the three sites, there were maximum densities of earthworms of about 300, 500, and 430 per sq. m. on the grass plots, 25 and 150 per sq. m. in the plots bearing green manures, and 30 per sq. m. in the clean cultivated experimental plots. Considered qualitatively, the small species (Allolobophora caliginosa, rosea and chlorotica) responded more clearly to the various soil treatments than did the large ones (Lumbricus terrestris and Allolobophora longa). Generally speaking, plots with short grass were more densely populated than those with long grass.

The connection between earthworm density and the various soil treatments was easily observed after 3 to 5 years regardless of the original state of the experimental plots.

Inst. App. Biol. Field Res. (Itbon), Arnhem, Netherlands.

Pinck, L. A., Soulides, D. A., and Allison, F. E. ANTIBIOTICS IN SOILS: II. EXTENT AND MECHANISM OF RELEASE. Soil Sci. 91: 94-99. 1961.

Bioassay results using the cylinder-plate method are reported for several antibiotics adsorbed on clay minerals and soils. These biological tests, like the previously reported physico-chemical studies, place the strongly basic antibiotics (streptomycin, dihydro-streptomycin, neomycin, and kanamycin) in one group, and the amphoteric ones (bacitracin, aureomycin, and terramycin) in another group. Antibiotics of the first group, with one exception, were not released from montmorillonite, vermiculite, or illite, but two or them (streptomycin and dihydrostreptomycin) were released to varying degrees from kaolinite; those of the second group were released from all of these clay minerals.

Assays of antibiotic-soil complexes gave results that agreed closely with expectations based on their clay mineral contents. Through the use of appropriate buffers it is possible to determine to some extent the types of clay minerals present in a given soil, if its organic matter content is low.

Antibiotic-clay complexes were shown not to diffuse through agar; the antibiotic is first released by an exchange reaction with the buffer and then diffuses through the agar.

SWCRD, ARS, USDA, Beltsville, Md.

Soulides, D. A., Pinck, L. A., and Allison, F. E. ANTIBIOTICS IN SOILS: III. FURTHER STUDIES ON RELEASE OF ANTIBIOTICS FROM CLAYS. *Soil Sci.* 92: 90-93. 1961.

Of the various buffers tested in connection with the release of antibiotics from their clay complexes the best results were obtained with phosphates for basic and with sodium citrate for amphoteric antibiotics.

A comparative study of Ionagar and agar as to the diffusibility of antibiotics showed that, with the exception of streptomycin and dihydrostreptomycin, Ionagar presented no advantage over ordinary agar.

Minimum detectable amounts of antibiotics released from their clay complexes were determined. These determinations revealed that the rate of release in amphoteric antibiotics is substantially higher than that in the basic antibiotics.

SWCRD, ARS, USDA, Beltsville, Md.

Valera, C. L., and Alexander, M. NUTRITION AND PHYSIOLOGY OF DENITRIFYING BACTERIA. *Plant and Soil.* 15(3): 268-280. 1961.

The size of both the denitrifying and the total bacterial population was found to be positively correlated with soil pH, but the denitrifying bacteria were more sensitive to acid environments than the bacterial microflora as a whole. The ecological evidence for a pH effect was supported by studies with individual pure cultures. The estimate of abundance of denitrifying micro-organisms was also affected markedly by the composition of the medium, and an improved medium was proposed.

Marked differences were noted in the nutrition of the bacteria capable of  $N_2$  production. In the absence of oxygen, certain strains developed readily using nitrate as the terminal electron acceptor for growth in media with no preformed growth factors, but others required ammonium or growth factors for denitrification to occur.

Jr. Author, Cornell U., Ithaca, N.Y.

McKee, G. W. SOME EFFECTS OF LIMING, FERTILIZATION, AND SOIL MOISTURE ON SEEDLING GROWTH AND NODULATION IN BIRDSFOOT TREFOIL. *Agron. J.* 53: 237-240. 1961.

The pH limits for nodulation were 4.5 and 7.9. However, growth and survival of the seedlings, as well as subsequent nodulation, were satisfactory only in a pH range of 6.2 to 7.5. Nodulation was retarded and depressed more than top or root growth by various liming and fertilizer treatments and by inadequate soil moisture. Nodulation may be retarded or completely inhibited on soils subjected to desiccation or to alternating periods of moisture and drouth.

Pa. Agr. Expt. Sta., University Park, Pa.

Erdman, L. W. THE FUTURE OF PREINOCULATED SEEDS. *Sixth Farm Seed Res. Conf. Proc.* pp. 7-14. 1961.

The progressive steps that marked the growth and development of the legume inoculation industry since its discovery in 1888 are given. It took almost 30 years for the practice of legume inoculation to become more or less stabilized. In 1915 there were only 50,000 bushel

units of inoculant sold; by 1926 there were 200,000 bushel units; by 1929 there were 1,500,000 bushel units; and by 1959 there were 24,149,000 bushel units.

In 1959, preinoculated alfalfa seed was introduced by one company and by 1960 at least seven different brands of preinoculated seed were offered.

Thirty-five tests at the Agriculture Research Service, Beltsville laboratory, in 1959 showed satisfactory inoculation in February and March of seed treated in January, but the majority of samples failed to show any live bacteria present in July.

The author concludes that the future of preinoculation rests with the producers of legume inoculants, seedsmen, warehousemen, seed dealers, and particularly those individuals who are licensees to treat the seeds in the manner laid down by the producers.

Seven warning signals are presented which may help to making preinoculation a success. The careful control of the moisture and temperature conditions is extremely important.

More intensified research, carefully controlled supervision, and an appreciation of the importance of all phases of the program may make possible a major breakthrough in this area of agricultural research.

SWCRD, ARS, USDA, Beltsville, Md.

Burge, W. D., and Broadbent, F. E. FIXATION OF AMMONIA BY ORGANIC SOILS. *Soil Sci. Soc. Amer. Proc.* 25: 199-204. 1961.

Ammonia fixation in organic soils of varying carbon content was found to be linearly correlated with percent carbon. In the presence of oxygen 1 molecule of ammonia was fixed per 29 atoms of carbon, and 1 for every 45 atoms of carbon in the absence of oxygen.

Treatment of these organic soils with ammonia usually resulted in decreased capacity to retain barium, and cupric ions, but the amount of ammonia fixed bore no quantitative relation to the decrease in cation retention.

Blocking hydroxyl groups in soil organic matter by treating with dimethyl sulfate decreased the capacity of the organic matter to fix ammonia, indicating that these groups are involved in the fixation reaction. Aldehyde groupings are apparently not involved. Formation of amides through the action of anhydrous ammonia on carboxylic esters may play a minor role in ammonia fixation.

A tracer experiment showed that fixed ammonia is slowly made available to plants.

Antelope Valley Field Station, Lancaster, Calif.

Koike, H. THE EFFECTS OF FUMIGANTS ON NITRATE PRODUCTION IN SOIL. *Soil Sci. Soc. Amer. Proc.* 25: 204-206. 1961.

Laboratory experiments were conducted to determine the effects of eight fumigants on the nitrification of  $(\text{NH}_4)_2\text{SO}_4$  and  $\text{NH}_4\text{OH}$  (aqua ammonia) in 200-g. samples of sugar cane field soils. All samples were incubated unamended and amended with 500 parts nitrogen as  $(\text{NH}_4)_2\text{SO}_4$  or  $\text{NH}_4\text{OH}$  per million parts soil. Unamended and nitrogen-amended soils were treated with the different fumigants. The soil samples were maintained at 50% moisture-holding capacity and, at intervals, extracted for ammonium and nitrate nitrogen.

Results indicate that DD at 40 gallons per acre, Telone at 40 gallons per acre, Dowfume W-85 at 8 gallons EDB per acre, S-1283 at 8 gallons per acre, and Vapam at 50 gallons per acre markedly inhibited nitrification for 4 to 8 weeks. The rate of nitrification increased appreciably shortly thereafter and decreased again as the supply of added ammoniacal nitrogen was depleted.

Allyl alcohol at 20 gallons per acre, Nemagon or DBCP at 3 gallons per acre, and PRD G-10 at 40 pounds active per acre were less toxic to the nitrifying bacteria.

An aromatic oil used as a diluent for some of the fumigants did not cause a significant reduction in the rate of nitrification in soil.

Lysimeter studies with DD substantiated results obtained with the fumigant in other experiments. For a period of 8 weeks, very little nitrate nitrogen was leached through the soils supplemented with NH<sub>4</sub>OH and fumigated with DD at the rate of 40 gallons per acre. In the soils which were not fumigated with DD, after the very slow initial rate during the first 2 weeks, nitrification proceeds uninhibited.

Hawaiian Sugar Planters Assoc., Honolulu, Hawaii.

Chandra, P., and Bollen, W. B. EFFECTS OF NABAM AND MYLONE ON NITRIFICATION, SOIL RESPIRATION, AND MICROBIAL NUMBERS IN FOUR OREGON SOILS. *Soil Sci.* 92: 387-393. 1961.

The organic fungicides nabam and mylone applied at field rates to fresh soils in the laboratory completely suppressed nitrification for 30 days. This effect lessened after 45 days, and by 60 days nitrification had recovered sufficiently to become approximately one-half that shown by the controls.

Each chemical greatly decreased the total mold population in each soil for 30 days. Numbers of bacteria and Streptomyces were decreased to a lesser extent. By 60 days the mold and bacterial populations showed significant increases. These results were similarly reflected by CO<sub>2</sub> production from soil respiration.

The effects were similar on four different soil types (Aiken, Amity, Chehalis, and Dayton).

Except for the temporary suppression of nitrification, the fungicides would seem to have no significant influence on general microbial activities of importance to soil fertility. For certain crops under some conditions the suppression and retardation of nitrification may be desirable.

Jr. Author, Oreg. Agr. Expt. Sta., Corvallis, Oreg.

Pokhiton, P. P. THE ROLE OF SHRUB ROOTS IN SUPPLYING SOIL WITH ORGANIC MATTER AND NITROGEN. *Soviet Soil Sci.* 12: 1311-1316. Dec. 1960.

In a study in Russia of the role of shrub roots in supplying soil with organic matter and nitrogen, the author draws the following conclusions:

1. Shrub vegetation actively causes organic matter and nitrogen to accumulate in the root zone of the soil. The amount of accumulation depends on the shrub species and on the saturation of the soil with roots, as well as on the soil type.
2. The humus increment in the root zone sharply increases under shrubs which provide maximum saturation of the soil with small roots. The highest percentage of humus increment is observed in podzolic sandy loam and the lowest in sod-podzolic sandy loam and dark gray forest soils.
3. In soil under shrubs, dying roots, roots of herbaceous vegetation penetrating the soil under the shrub canopy, and the surface litter-fall, were sources of organic matter. Root secretions may be of great importance.
4. No clear relationship was detected between the increase in the content of water-soluble organic matter in the root zone of soil under shrubs and the shrub species and saturation of the soil with roots.

5. Nitrogen accumulation in the shrub root zone of soils occurs primarily in protein form. Humic substances, organic and mineral root secretions, and soil microorganisms and invertebrates can be sources of nitrogen in soil under shrubs.
6. The possibility of enriching the soil with organic material and nitrogen by an appropriate selection of shrub vegetation and by adjusting the composition of existing shrub plantations opens up new opportunities for increasing the yield of plantations for industrial and special purposes such as soil and field protection, melioration, water conservation, decoration, and display.

Amer. Institute Biol. Sci., 2000 P St., N. W., Washington 6, D.C.

### Soil-Plant-Animal Relationships

Walker, D. R., and Bentley, C. F. SULPHUR FRACTIONS OF LEGUMES AS INDICATORS OF SULPHUR DEFICIENCY. *Canad. J. Soil Sci.* 41: 164-168. 1961.

A study of 157 locations, representing 18 soil series in west central Alberta, revealed that yield responses of alfalfa, alsike clover, and red clover to applications of sulphur fertilizer were not confined to either specific soil series or definite geographical areas.

Samples of the 3 legume crops from 74 of the test locations were analyzed to determine the usefulness of three sulphur fractions and of the ratio total nitrogen: total sulphur as indicators of the need for sulphur fertilization. Extractable sulphur and extractable sulphate were present in considerably larger quantities in alfalfa and alsike clover grown on non-sulphur-deficient soils as compared with samples from soils deficient in that element. These determinations offer a possible means of detecting the need for sulphur fertilization with those two legume crops. While total sulphur and the total nitrogen-total sulphur ratio also showed differences, their magnitude was not of the same order as with these two fractions.

Similar determinations for red clover showed the differences to be smaller than for alfalfa and alsike clover and they appear to be of doubtful value for predicting the need for sulphur fertilization.

Res. Br., Canada Dept. Agr., Lacombe, Alta Alberta, Canada.

Lingle, J. C., Sciaroni, R. H., Lear, B., and Wight, J. R. THE EFFECT OF SOIL LIMING AND FUMIGATION ON THE MANGANESE CONTENT OF BRUSSEL SPROUTS LEAVES. *Proc. Amer. Soc. For Hort. Sci.* 78: 310-318. 1961.

Severe marginal and interveinal chlorosis and necrosis of the older leaves of Brussel sprouts were found to be associated with excess Mn content of the leaves. This was in turn found to be related to low soil pH.

Soil liming with dolomite and hydrated lime reduced the Mn concentration in the leaves, and increased growth and yield.

Manganese concentrations in the leaves declined as the plants grew older. Soil fumigation also reduced Mn concentrations in the leaves. It is suggested the leaves having Mn in excess of 1000 p.p.m. are affected with Mn toxicity.

Much more lime was necessary to achieve a desirable pH than laboratory tests indicated. The reason is not known.

U. Calif., Davis, Calif.

Martin, J. P., Harding, R. B., and Garber, M. J. RELATION OF SOIL PROPERTIES AND PLANT COMPOSITION TO GROWTH OF CITRUS SEEDLINGS IN 100 NONFUMIGATED AND FUMIGATED OLD CITRUS SOILS. *Soil Sci.* 91: 317-323. 1961.

Sweet orange seedlings were grown in the greenhouse in 98 old citrus and 4 noncitrus fumigated and nonfumigated soils, and relative growth correlated by multiple-regression analysis with soil chemical, physical, and biological properties and with plant composition. Relative growth varied from 16 to 87 percent in the nonfumigated soil and from 26 to 116 percent in the fumigated soil. Fumigation of the soil with propylene oxide increased seedling dry weights by 20 to 211 percent in 87 of the soils, and increased the leaf Ca, Mg, and B, and slightly reduced the P contents of the plants grown in the majority of the soils. Fumigation also corrected Mn deficiency of plants grown in the soils of low Mn availability. Very poor growth in the fumigated soils was associated with exchangeable Na percentages  $>5$ , low soluble-P values, sticky clay loam soils, or with very sandy type soils. In the nonfumigated soils, relative growth was negatively correlated with pH of soil paste, exchangeable K, soluble  $\text{HCO}_3$ , leaf Na, root Na, root Mg, soluble  $\text{NO}_3$ -N in the original soils, and root Ca. In the fumigated soil, by itself exchangeable Na was observed to have a relatively high negative correlation with growth, but in relationship to the other important variables its contribution was outstanding. In addition, percent silt and acid-soluble P were positively correlated, and exchange capacity and root Mg negatively correlated, with yield. The study supports the observation that citrus plants will make relatively good growth over a wider range of certain soil properties in the absence of plant root parasites than in their presence.

U. Calif., Riverside, Calif.

Walker, D. R., and Mason, D. D. NUTRITIONAL STATUS OF APPLE ORCHARDS IN NORTH CAROLINA. *Proc. Amer. Soc. For Hort. Sci.* 75: 22-31. 1960.

Leaf analyses and nutrient-element deficiency symptoms of apple trees in North Carolina in 1956 indicated that nitrogen, boron, and magnesium were deficient in many orchards. Zinc deficiency symptoms were found in two orchards and foliar zinc was low in many leaf samples. Differences occurring among the nutrient-elements are discussed in regard to season and variety. The level of leaf phosphorus and potassium were approximately the same in trees that had or had not received these fertilizers.

Soil calcium, magnesium, manganese, phosphorus, and potassium were present at a medium or high level in all soil samples except in the subsurface soil of one county. Correlations between leaf and soil samples collected in the same orchards for calcium, potassium, and phosphorus were statistically significant; however, only a relatively small percentage of the variation in the leaf tissue could be accounted for by the soil levels of the nutrient-elements. Correlations of soil pH and leaf calcium and magnesium were not significant. There were no consistent relationships between the leaf and soil correlations that were made.

N. C. State Col., Raleigh, N.C.

Buttery, R. F., and Ehrenreich, J. H. NUTRITIVE QUALITY OF LITTLE BLUESTEM IN THE MISSOURI OZARKS. *Central States Forest Expt. Sta. Tech. Paper* 179, 9 pp. 1961.

Little bluestem ranges do not furnish good enough forage for year-round grazing, but when used in a ranch operation, which includes improved pasture and supplemental feeding, they can furnish nutritious forage for several months. The actual length of time would depend

upon many factors such as site, range condition, season of use, fencing, location of salt and water, precipitation, and class of cattle. Generally speaking, however, because of the variety of forage species and forage regrowth, properly stocked little bluestem range in good condition should be able to furnish adequate nutrients from about mid-April through mid-August in the Missouri Ozarks.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Fernandez, C. E. THE EFFECT OF TRIIODOBENZOIC ACID, UREA AND IRON IN CORRECTING IRON CHLOROSIS IN COFFEE. Proc. Amer. Soc. for Hort. Sci. 77: 236-239. 1961.

Leaves of coffee plants showing symptoms of iron chlorosis were treated with iron sulfate in combination with TIBA and urea. The application of TIBA and iron caused a marked recovery of the green color of the leaf. The effect does not seem to be the result of increased movement of iron, nor the enhancement of foliar absorption of iron salts. TIBA may alter some metabolic condition that permits the added iron to stay in active form long enough to allow for chlorophyll synthesis.

Plant Industry Dept., Interamerican Inst. Agr, Sci., Turrialba, Costa Rica, Central America.

Senewiratne, S. T., and Mikkelsen, D. S. PHYSIOLOGICAL FACTORS LIMITING GROWTH AND YIELD OF ORYZA SATIVA UNDER UNFLOODED CONDITIONS. Plant and Soil 14: 127-145. 1961.

Rice grown under flooded conditions consistently produces better vegetative growth and higher grain yields than when grown in unflooded culture. Physiological and nutritional differences in rice grown under these two conditions were determined. Growth observations showed that plants under unflooded culture made an initial vigorous start, but soon showed poor tillering, depressed leaf growth, delayed flowering, low moisture content, foliar chlorosis, and 52.6 percent lower yield than flooded plants.

Chemical analysis showed higher manganese content of plants grown under unflooded culture with no significant differences in other elements. Plants grown in nutrient cultures and under field conditions gave evidence that nitrate nitrogen nutrition, as exists for plants under unflooded conditions, favored manganese accumulation.

Growth responses suggest differences in auxin metabolism. Since auxins could not be estimated directly, some factors affecting auxin degradation were investigated. It was found that plants grown under unflooded conditions had: (1) A low catalase activity; and (2) a high peroxidase activity, which favor accelerated auxin degradation.

Jr. Author, U. Calif. Davis, Calif.

Goldman, C. R. MOLYBDENUM AS A FACTOR LIMITING PRIMARY PRODUCTIVITY IN CASTLE LAKE, CALIFORNIA. Sci. 132(3433): 1016-1017. Oct. 14, 1960.

A trace-element deficiency is evident from carbon-14 bioassays of Castle Lake's natural phytoplankton populations. Increase in photosynthetic rates with the addition of molybdcic acid or sodium molybdate was demonstrated throughout the year. Other trace elements may also be found to be limiting factors in lakes having a limited watershed.

The alder trees (Alnus tenuifolia Nutt) that are abundant along the east shore of Castle Lake make an appreciable nitrogen contribution to the lake, principally in the form of  $\text{NO}_3^-$ . Analysis of alder leaves showed molybdenum to be present in trace quantities (<0.1 part per million). The nitrogen-fixing alder trees and other plants may be competing with the lake for the available Mo,  $\text{K}^+$ , and  $\text{SO}_4^{--}$  which would otherwise be added by the springs draining the alder-covered shore line.

U. Calif., Davis, Calif.

Fernandez, C. E., and Childers, N. F. MOLYBDENUM DEFICIENCY IN APPLE. Proc. Amer. Soc. for Hort. Sci. 75: 32-38. 1960.

Molybdenum deficiency symptoms of Rome Beauty apple seedlings consisted of a uniform chlorosis of young leaves, scorching of the tips and then the margins of old leaves, and eventual downward cupping. The Mo-deficient older leaves showed high nitrate accumulation. The general vigor and growth of deficient plants were reduced. Chlorosis of the younger leaves on Mo-deficient plants was corrected and shoot growth was resumed by the addition of 0.01 p.p.m. Mo to the nutrient solution.

A bio-assay technique using Aspergillus niger is described for determining Mo in small amounts of apple leaf tissue. This technique was used to determine foliar Mo in 100 apple orchards distributed throughout New Jersey. The Mo content of the foliage averaged 0.09 p.p.m. to June, 0.19, p.p.m. in July, and 0.12 in August. The peak obtained in July was found to be correlated positively with soil pH and negatively with soil and leaf Mn. July appears to be the best month to sample leaves for Mo content under conditions of this survey.

Mo deficiency symptoms were apparent on apple in greenhouse solution culture when the foliar Mo was 0.05 p.p.m.

Very low seasonal averages of foliar Mo (0.06 to 0.10 p.p.m.) were found in the leaves of apple trees in several New Jersey orchards.

Rutgers, The State U. N. J., New Brunswick, N.J.

Fleming, C. E., McCormick, J. A., and Dye, W. B. THE EFFECT OF MOLYBDENOSIS ON A GROWTH AND BREEDING EXPERIMENT. Nev. Agr. Expt. Sta. B. 220, 15 pp. 1961.

Molybdenosis, or molybdenum toxicity, is an ever present problem with ranchers in certain areas of Nevada and California. Symptoms of molybdenosis or "alkalized" cattle are scouring, unthriftiness, and rough hair coat in the earlier stages. In later stages, symptoms include hair color change (red to straw color or black to mouse gray), dehydration, arching of the back, listlessness and weakness, brittle bones, emaciation, and, in more extreme cases, death.

A follow-up of an experiment of Molybdenosis (Nev. Expt. Sta. B. 208, 1960, reported in ABSTRACT 20, pp. 152) was completed. The two heifers reported in this earlier work were subjected to further study for an additional 20-month period. Although this investigation involved only the two animals, the data indicate: (1) Cattle that have recovered entirely or partly from molybdenosis will continue to grow satisfactorily without further copper glycinate treatments, if fed an adequate diet; (2) cattle that have been severely stunted by molybdenosis over a long period of time will never reach the same size as unaffected cattle, other factors being the same; (3) a heifer that has recovered from molybdenosis, even though stunted can produce a normal size calf; and (4) a recovered, though stunted, bovine does not show osteoporosis (spongy bones).

Agr. Expt. Sta., Max C. Fleischmann Col. Agr., U. Nev., Reno, Nev.

Kubota, J., Lazar, V. A., Langan, L. N., and Beeson, K. C. THE RELATIONSHIP OF SOILS TO MOLYBDENUM TOXICITY IN CATTLE IN NEVADA. *Soil Sci. Soc. Amer. Proc.* 25: 227-232. 1961.

The relationship of soil factors associated with reported areas of Mo toxicity in cattle in seven agriculturally important valleys in Nevada was investigated. The level of Mo in the plant was selected as a measure of the soil factors, but Cu, Co, S, and P were also determined in a large number of the forage samples.

The Mo content varied both with plant species and soils. Under Nevada conditions, alfalfa contains about two-thirds as much Mo as does the clover, and sedge about one-sixth as much where the Mo contents are very high. Grasses and sedges with high levels of Mo commonly have correspondingly low levels of Cu, Co, or P.

The Mo levels were low in forage plants from the naturally well-drained soils, and the levels of Cu, Co, S, and P were considered to be adequate. Neither lithology nor physiography--alluvial fan or floodplain and terrace--is an important factor in well-drained soils.

Both high water table and surface organic accumulation, common soil characteristics of poorly drained soils, affect the Mo levels in the plant. The magnitude of their effect varies with kind of parent material. The exceedingly high (300 p.p.m.) Mo levels were found in forage from some granitic alluvial fans.

The relationship of problem soil areas in Nevada to other Mo toxic areas is discussed.

SCS, USDA, Ithaca, N.Y.

Oertli, J. J., and Kohl, H. C. SOME CONSIDERATIONS ABOUT THE TOLERANCE OF VARIOUS PLANT SPECIES TO EXCESSIVE SUPPLIES OF BORON. *Soil Sci.* 92: 243-247. 1961.

Various plant species were grown in sand cultures with 10 p.p.m. boron. The necessary duration of the treatment to produce necrotic boron toxicity symptoms was recorded, and the boron contents of necrotic, chlorotic, and green areas determined.

The distribution of boron in leaves and the pattern of boron toxicity are both related to the venation of the leaf and are in agreement with the hypothesis that most boron is moved in the transpiration stream and as water is lost through transpiration it is concentrated in the liquid in the leaf.

The boron distribution in leaves is very uneven, necrotic spots usually contain more than 1,500 p.p.m. Around 1,000 p.p.m. chlorosis may be expected, while the green areas of the same leaves may contain boron from below 100 p.p.m. up to nearly 1,000 p.p.m. No principal differences in sensitivity to boron tissues of various plant species could be observed, and it appears that tolerant species must accumulate boron at a slower rate. The concentration of boron in the transpiration stream in localized areas may serve to explain why there is a relatively narrow range between deficient and toxic boron concentrations in the soil solution. This localization of the boron toxicity may further explain why there is often no pronounced reduction in yield associated with boron toxicity.

U. Calif., Los Angeles, Calif.

Burleson, C. A., Dacus, A. D., and Gerard, C. J. THE EFFECT OF PHOSPHORUS FERTILIZATION ON THE ZINC NUTRITION OF SEVERAL IRRIGATED CROPS. *Soil Sci. Soc. Amer. Proc.* 25: 365-368. 1961.

Phosphorus fertilization may induce Zn deficiencies in some crops under certain soil and climatic conditions. Phosphorus-induced zinc deficiencies are probably enhanced by cold, wet soils during the early part of the growing season by restricting root development near to the

zone of fertilizer placement. The mechanisms involved in the induction of Zn deficiency by P fertilization are not fully understood.

In greenhouse experiments with Red Kidney beans (*Phaseolus vulgaris*), severe P-induced Zn absorption was increased by P fertilization. Zinc absorption was increased by Zn fertilization and decreased by P fertilization. Phosphorous uptake was increased with P fertilization and decreased by Zn fertilization. When both Zn and P were applied, the uptake of both Zn and P were reduced.

Lower Rio Grande Valley Expt. Sta., Weslaco, Tex.

Olsen, S. R., Watanabe, F. S., and Danielson, R. E. PHOSPHORUS ABSORPTION BY CORN ROOTS AS AFFECTED BY MOISTURE AND PHOSPHORUS CONCENTRATION. *Soil Sci. Soc. Amer. Proc.* 25: 289-294. 1961.

The relative uptake of P by corn seedlings was 100, 94, 80, 50, and 35 for 1/3, 1/2, 1, 3, and 9 bars soil moisture tension, respectively. Uptake of P was a linear function of the soil moisture content for a given soil. Thickness of moisture films, diffusion path length, degree of hydration, and elongation of the roots appeared to be the factors controlling P uptake in relation to moisture tension. Uptake of P at constant moisture tension on soils differing in texture and soluble P level was a linear function of solution P concentration, but the range of concentration investigated was small. Phosphorus uptake from a soil-root system differs appreciably from a solution-root system, which suggests that the soil introduces a limiting factor in rate of P uptake.

SWCRD, ARS, USDA, Ft. Collins, Colo.

Rodney, D. R., and Sharples, G. C. RESPONSES OF LISBON LEMON TREES TO APPLICATIONS OF NITROGEN, PHOSPHATE, AND MANURE. *Proc. Amer. Soc. for Hort. Sci.* 78: 181-185. 1961.

Yield and leaf composition data are presented from a 3 x 2 x 2 (nitrogen x phosphate x steer manure) factorial experiment on Lisbon lemons growing in a calcareous sandy soil on the Yuma Mesa in southwestern Arizona.

Increasing N fertilization from 1 pound/tree/year to 2-1/2 or 4 pounds resulted in no increase in the number of fruit produced except where phosphate or steer manure were supplied in addition to the N.

Fruit sizes were increased by applications of steer manure, but not by other fertilizer treatments.

The P content of leaves was unrelated to phosphate applications but was inversely related to the amount of N applied.

The K content of leaves was relatively high in the low N series of treatments and lower where phosphate and higher levels of N were applied.

U. Ariz., Agr. Expt. Sta., Tucson, Ariz.

Berger, K. C., Potterton, P. E., and Hobson, E. L. YIELD, QUALITY, AND PHOSPHORUS UPTAKE OF POTATOES AS INFLUENCED BY PLACEMENT AND COMPOSITION OF POTASSIUM FERTILIZERS. *Amer. Potato J.* 38: 272-285. 1961.

Field trials were conducted for several years using three different potato varieties on three different Wisconsin soil types. Comparisons were made between band and broadcast applications of potassium salts containing chlorides and sulfates.

Chlorides, banded in the row with the phosphorus and nitrogen fertilizer, inhibited phosphorus uptake and reduced yield and dry matter content of potatoes when compared to sulfates. Separation of the chloride from the phosphorus fertilizer, by broadcasting the chloride and banding the phosphorus, increased phosphorus uptake and yields in most cases.

Potassium sulfate was a better source of potassium than potassium chloride when applied banded in the row with the phosphorus and nitrogen fertilizer. Sulfate of potash-magnesia appeared to be the best source of potash, increasing potato yields and improving quality.

Potatoes receiving sulfate had thicker, darker-colored leaves than those receiving chloride. The leaves of plants receiving chloride were very light-colored and thin.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

Dumenil, L. NITROGEN AND PHOSPHORUS COMPOSITION OF CORN LEAVES AND CORN YIELDS IN RELATION TO CRITICAL LEVELS AND NUTRIENT BALANCE. *Soil Sci. Soc. Amer. Proc.* 25: 295-298. 1961.

The relationship between corn yields and the N and P contents of corn leaves was determined in 93 fertilizer experiments by multiple curvilinear regression. The objective was to investigate critical levels and nutrient balance. Equal yields occurred at varying concentrations of N and P in the corn leaf within certain limits. The N or P content in the corn leaf at 95% of maximum yield varied with the concentration of the other nutrient because of their significant interaction on yield. Hence, the critical N or P level is not a point nor narrow range of values but includes a wide range of values depending on how it is defined and on the level of the other nutrient in the leaf. The N-P nutrient balance appeared to be critical only at or near the maximum yield. Nutrient unbalance may occur when the leaf N or P content extends beyond a certain limit in relation to the other one.

Iowa State U., Ames, Iowa.

Yoshida, D., and Takahashi, T. RELATION BETWEEN THE BEHAVIOR OF NITROGEN AND THE NICOTINE SYNTHESIS IN TOBACCO PLANT. *Soil Sci. and Plant Nutr.* 7 (4): 157-164. 1961.

A great portion of nicotine in tobacco plant is synthesized during the period after topping time than at the ripening period. Behaviours of nitrogen absorbed before and after topping time were investigated with special reference to the incorporation of the nitrogen into nicotine.

Tobacco plants were able to synthesize the nicotine with the utilization of the nitrogen absorbed before topping time, even when nitrogen supply was stopped after topping time such as in water culture.

Experiments, in which nitrogen supplied after topping time was labeled with  $N^{15}$ , indicated that the nitrogen absorbed after topping time was incorporated uniformly into the total-and protein-nitrogen among the various plant organs. Considerable amounts of protein-nitrogen in the leaves were changed to non-protein-nitrogen and translocated through the plant after topping time. It was concluded that the nitrogen in the plant was very easy to move, the movement was accompanied with the decomposition of leaf protein, and the changes in nitrogen amount were loss of leaf nitrogen and accumulation of nitrogen in the stem and root.

Synthesis of nicotine would be closely related with this vigorous movement of nitrogen in the plant. Nitrogen absorbed after topping time was incorporated into nicotine uniformly among various plant parts. It was apparent that the nicotine is synthesized using the nitrogen presented anywhere in the tobacco plant and absorbed at both before and after topping time.

Uniform incorporations of ammonium-nitrogen supplied after topping time among the various parts of plant and the various fractions of nitrogen in plant were not obtained.

Nitrogen absorbed after topping time was effectively incorporated into nicotine compared with nitrogen absorbed before topping time.

The earlier the plants were topped, the higher the increase in nicotine synthesis were obtained. This would be attributed to the more nitrogen application to the root caused by the topping at the earlier stage of growth.

Hotano Tobacco Expt. Sta., Hotano, Japan.

Rumburg, C. B., and Cooper, C. S. FERTILIZER-INDUCED CHANGES IN BOTANICAL COMPOSITION, YIELD, AND QUALITY OF NATIVE MEADOW HAY. *Agron. J.* 53: 255-258. 1961.

The effects of nitrogen, phosphorous, and manure on the botanical composition of native flood meadows were studied over a 4-year period. The treatments were also evaluated in terms of yield and quality of the new plant populations.

Annual applications of ammonium nitrate, treble superphosphate, and manure were made in factorial combination at rates of 0, 200, 400, and 600 pounds of N per acre; 0 and 240 pounds of P<sub>2</sub>O<sub>5</sub> per acre; and 0 and 20 tons of manure per acre, respectively.

The actual yields of grasses increased with increasing rates of N. At 400 and 600 pounds of N per acre total hay yields were composed almost entirely of grasses. Meadow barley (*Hordeum brachyantherum*) and beardless wild-rye (*Elymus triticoides*) made a greater response than other grasses investigated.

Nitrogen at 200 pounds per acre resulted in an increase in yields of rush and sedge, but at 400 and 600 pounds per acre greatly depressed it. The percent composition by weight of rush and sedge in the hay showed a continual decrease with increasing levels of N.

Yields of hay were significantly increased with N, P, and manure. However, there was no significant difference (0.05 level) among rates of 400 and 600 pounds of N per acre.

Nitrogen actually resulted in a decrease in the crude protein content in the forage due to the elimination of whitetip clover with the application of 200 pounds of N per acre, and only a slight increase in crude protein in the grasses with increasing rates of N application.

The phosphorus content in the hay decreased with increasing rates of N and increased with applications of P and manure.

CRD, ARS, USDA, Burns, Oreg.

Singh, R. N., and Seatz, L. F. ALFALFA YIELD AND COMPOSITION AFTER DIFFERENT TIMES AND RATES OF LIME AND PHOSPHORUS APPLICATION. *Soil Sci. Soc. Amer. Proc.* 25: 307-309. 1961.

Lime and phosphorus applications were made to a Hartsells ls with a pH of 4.7 and an extremely low available phosphorus supply. Lime rates of 0, 1, 2, and 4 tons per acre and

$P_2O_5$  rates of 0, 40, 80, and 120 pounds per acre were applied 3 months before planting and at planting in the four possible time-of-application combinations. Two crops of alfalfa were harvested and yield and P content were determined.

High significant yield increases to both lime and phosphorus applications were found. The highest yield was obtained when the highest rates of lime and phosphorus were both applied at the time of planting. Phosphorus applications to the unlimed soil were not so effective, even though the soil was limed 3 months after the phosphorus was applied, as when the phosphorus was applied to the limed soil. These results indicate that the rate of equilibrium of phosphorus compound formation in soils at different pH levels may occur very slowly.

Jr. Author, Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Jones, W. W., Cree, C. B., Embleton, T. W. SOME EFFECTS OF NITROGEN SOURCES AND CULTURAL PRACTICES ON WATER INTAKE BY SOIL IN A WASHINGTON NAVEL ORANGE ORCHARD AND ON FRUIT PRODUCTION, SIZE, AND QUALITY. Proc. Amer. Soc. for Hort. Sci. 77: 146-154, 1961.

The influence of nitrogen fertilizers and of cultural practices on water infiltration into the soil and the relation of these to yields were studied for 7 years, 1953-59, in an orchard that has been differentially fertilized and cultivated for more than 30 years, 1927-59. During the 6-year period, 1954-59, some of the plots were changed from clean cultivation to non-tillage in which all weeds were killed with oil.

The net water intake and yields were least where  $NaNO_2$  and  $(NH_4)_2SO_4$  were used as sources of N. These detrimental effects were reduced by the application of gypsum with  $NaNO_3$  and of limestone with  $(NH_4)_2SO_4$ . The effects of  $NaNO_3$  and  $(NH_4)_2SO_4$  were also partly corrected by changing the culture from clean cultivation to nontillage.

Plots on which winter covercrops were grown had a greater net water intake and greater yields than plots that were kept clean by discing. When the clean-cultivated plots were changed to nontillage, net water intake increased so that 1 year after the change the nontilled treatments had a greater net water intake than did the winter covercropped treatments, and yields became greater 2 years after the change.

Fruit from the nontilled plots, compared with that of the covercropped plots, was larger and had a lower Brix, a lower percentage of acid, less Vitamin C, less N, and less K but a higher percentage of juice, more P in the juice, a higher Brix/acid ratio, and a thinner peel.

The trend line for net water intake during the 6 years of this study has been up for the nontilled treatments and down for the winter covercropped treatments.

U. Calif. Citrus Expt. Sta., Riverside, Calif.

Casper, H. R., and Thomas, J. R. INFLUENCE OF SUPPLEMENTAL RUN-OFF WATER AND FERTILIZER ON PRODUCTION AND CHEMICAL COMPOSITION OF NATIVE FORAGE. J. Range Mangt. 14: 292-297. 1961.

The effects of supplemental water and the nitrogen-phosphorus fertilizer ratio on the yield and chemical composition of forage native to western South Dakota were investigated.

Nitrogen fertilizer increased the production of forage and crude protein on both the dry land and water spreading sites. The supplemental water received on the water spreading site increased the efficiency of use of the applied nitrogen.

Increases in forage yields on the dry range and water spreading site were significantly correlated with increases in percent crude protein.

Phosphorus fertilizer increased forage and crude protein yields on the dry range site but had little influence on yields where supplemental water was used.

The percentage nitrogen of the forage was significantly increased by the application of nitrogen fertilizer but decreased with the use of supplemental water.

Recovery of applied nitrogen was enhanced by the additional water received on the water spreading site.

Phosphorus content of the forage increased with the addition of phosphorus fertilizer and with the use of supplemental water.

SWCRD, ARS, USDA, Newell, S. Dak.

Atwood, W. M., and Zuckerman, B. M. THE EFFECTS OF FERTILIZER AND FUNGICIDE COMBINATIONS ON THE QUALITY OF CRANBERRIES. Proc. Amer. Soc. for Hort. Sci. 77: 359-366. 1961.

The ratio of complete fertilizer used apparently had no effect on the total rot of cranberries, but rot increased as the rate of application was increased. Field observations indicated that heavy vine growth and the conditions which favor the development of rot are directly related. For this reason, it is probable that any factor that serves to cause heavy vine growth will indirectly cause an increase in fungus-induced berry breakdown. The fruit rot appears to be an indirect effect of the fertilizer applications.

Of the 5 sources of N, UF (urea-formaldehyde), and NaNO<sub>3</sub> resulted in no significant increase in rot. NH<sub>4</sub>NO<sub>3</sub>, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and urea produced increasing percentages of rot in this order. UF and NaNO<sub>3</sub> at rates up to 80 pounds of N per acre did not affect the soundness of berries significantly, but the other 3 materials resulted in significant increases in rot even at the lowest rate of 20 pounds of N per acre. This indicated that N from slowly available sources and from nitrate was best suited for the production of sound fruit.

Minor elements had little or no effect on the amount of total rot produced. Plots treated with copper had less rot, but this was probably due to the form of the material applied and the resultant fungicidal action.

The experiments show that the use of certain forms of fertilizer is related to the percent of rot, which occurs in the mature fruit. This fruit rot, at least under some conditions, eliminates the advantages that accrue from increased yield. When fungicides as well as fertilizer were applied, the rot was reduced to the point where the increased yields became profitable. Fertilizer had considerable effect on vine growth but the marketable yield was increased significantly only when fungicide-fertilizer treatments were utilized.

U. Mass., East Wareham, Mass.

Willhite, F. M. MOUNTAIN MEADOW FORAGE AND BEEF PRODUCTION AS AFFECTIONED BY COMMERCIAL NITROGEN. Amer. Soc. of Anim. Prod. West. Sect. Proc. 12: 337-343. 1961.

Three classes of livestock were fed forages over a period of 7 years to evaluate the effect of applying commercial nitrogen to a mountain meadow in comparison with nitrogen supplied by growing legumes in association with grass. The performance of growing cattle (weaners, yearlings, and two-year-olds) shows that forage consisting of grass and legumes, with nitrogen supplied by the grass-legume association, produced gains at a rate of 0.14

pound more per day than cattle fed forages produced from the use of commercial nitrogen. There was little difference between the two forages as measured by the daily intake per 100 pounds of live weight. This would indicate no difference in palatability. On the other hand, since the rate of gain on the straight grass hay produced from nitrogen fertilization was less, there would seem to be a possibility of a deficiency of some growth factor in this hay.

Annual application of 180 pounds of nitrogen per acre to a grass-legume meadow for 7 years produced a 1.6 tons annual increase in hay yield over the unfertilized meadow. Integration of this yield increase from nitrogen and the performance of two classes of livestock shows a carrying capacity increase of 123 days per acre in cows and calves, and 300 days in yearlings. The beef yield increases, respectively, were 181 and 282 pounds per acre yearly.

SWCRD, ARS, USDA, Colo. State U., Grand Junction, Colo.

Boawn, L. C., Viets, F. G., Jr., Nielson, C. E., and Crawford, C. L. YIELD AND ZINC CONTENT OF SUGAR BEETS AS AFFECTED BY NITROGEN SOURCE, RATE OF NITROGEN, AND ZINC APPLICATION. *J. Amer. Soc. Sugar Beet Technol.* 11(4): 279-286. 1961.

Sugar beets were grown the third year of a cropping sequence on plots treated with a factorial combination of three nitrogen carriers, three rates of nitrogen, and five rates of zinc. Increasing the nitrogen rate from 0 to 160 pounds per acre increased the beet yields from 14 tons per acre to about 30 tons per acre. Nitrogen carrier had no effect on yield. The rates of nitrogen applied caused the average sugar percentage to decrease from 18.13 to 17.11 percent. Zinc rates from 0 to 16 pounds per acre had no effect on either yield or sugar percentage.

Nitrogen rate and nitrogen carrier had no effect on the zinc content of various plant parts. Sixteen pounds of zinc per acre, applied 2 years earlier, increased the zinc content of leaf blades from 20 p.p.m. to slightly over 30 p.p.m., of total tops from 12 p.p.m. to 22 p.p.m., and roots from 8 p.p.m. to 12 p.p.m. These increases in the level of zinc in the plant did not produce a measurable increase in beet yield.

The total zinc contained in a beet crop yielding 30 tons per acre varied from 0.183 pounds to 0.268 pounds per acre depending on the level of zinc fertilization.

SWCRD, ARS, USDA, Prosser, Wash.

Greig, J. K., and Smith, F. W. SWEETPOTATO GROWTH, CATION ACCUMULATION AND CAROTENE CONTENT AS AFFECTED BY CATION LEVEL IN THE GROWTH MEDIUM. *Proc. Amer. Soc. for Hort. Sci.* 77: 463-472. 1961.

The effects of cation additions, by synthetic resins, to Sarpy fsl soil on vegetative growth, fleshy root growth, cation accumulations, and carotene content of fleshy roots were determined.

In the first experiment, addition of Ca and Mg did not affect weight of plant material, but additions of Na and K caused a reduction in weight and ultimate death of plants. Ca and Mg treatments stimulated fleshy root formation. Fleshy roots did not form with the K, Na, or mixed treatments. Cation accumulation in the vegetative portion of the plant generally increased with increased concentration of the cation in the growth medium. Sodium at the rates used was most detrimental to plant growth. This detrimental effect was probably due mainly to its quick dissociation from the exchange resin as compared with the rather slow

dissociation of divalent cations. Increased uptake of Na resulted in decreased uptake of Ca, K, and Mg. A nutrient deficiency of these cations probably existed. Sweetpotato plants accumulated Na very readily when it was available in the growth medium.

In the second experiment, addition of Na to the growth media reduced both weight and carotene content of fleshy roots, but induced greatest vegetative development. The greatest K concentration added to the soil material significantly increased carotene content of fleshy roots. This indicated that even though K did not increase the vegetative growth, additional K improved the value of the sweetpotato nutritionally by inducing greater carotene accumulation in the root. Accumulation of cations by fleshy roots generally was in proportion to quantity of cations added to soil. Maximum safe cation concentrations of Ca, K, and Na were established. These cation concentrations were: Ca in excess of an amount equivalent to the original exchange capacity of the soil, K in excess of 0.4 times the original exchange capacity of the soil, and Na in excess of 0.1 times the original exchange capacity of the soil.

Kans. Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Martin, J. P., Ervin, J. O., and Shepherd, R. A. INFLUENCE OF EXCHANGEABLE NA AND K AT DIFFERENT BASE-SATURATION LEVELS ON GROWTH AND COMPOSITION OF CITRUS PLANTS. *Soil Sci.* 91: 273-279. 1961.

The influence of the degree of base saturation of Yolo s1 and Hanford s1 on the tolerance of sweet orange seedlings to relatively high exchangeable K and Na percentages was studied. Increasing exchangeable Na and K decreased plant growth. The magnitude of growth reduction was greater in base-saturated soils or soils containing excess lime, or both, than in 70 percent base-saturated soils. With the exception of K and Ca concentrations in the plants grown in Yolo s1, the greater growth retardation in the high-lime series caused by comparable Na or K percentages was not associated with marked differences in Na or K absorption nor with greater reduction of Ca or Mg absorption. Excess lime reduced leaf Mn, Zn, Cu, Fe, and B.

U. Calif., Citrus Expt. Sta., Riverside, Calif.

Venkataraman, K. V., and Tejwani, K. G. FURTHER STUDIES ON THE NUTRITIONAL BALANCE IN FLUE-CURED TOBACCO: INTERRELATIONSHIPS BETWEEN CATIONS ACCUMULATED IN THE LEAVES. *Soil Sci.* 91: 324-327. 1961.

Based on the results of leaf analysis of flue-cured Virginia tobacco samples collected from different areas and varying widely in their composition and quality, the relationships between the cations accumulated in the leaf were studied. The studies indicate the following relationships in the nutritional balance of flue-cured tobacco leaf: (1) Ca depresses the accumulation of K in the leaf; (2) Mg has little direct influence on the accumulation of K; (3) Ca and K promote the accumulation of Mg in the leaf; and (4) both Mg and K influence the accumulation of Ca in the leaf, the former promoting it and the latter depressing it.

These studies explain why the total cation content of leaves of varying composition is not always a constant in flue-cured Virginia tobacco.

Cent. Tab. Res. Inst., Rajahmundry, India.

Singh, J. N., and Lal, K. N. ABSORPTION AND ACCUMULATION OF POTASSIUM IN COMPONENT PARTS OF SUGARCANE AS Affected BY AGE, PHOSPHORUS DEFICIENCY AND PHOSPHORUS FERTILIZATION. *Soil Sci. and Plant Nutr.* 7(4): 139-145. 1961.

The effects of phosphorus deficiency and of phosphorus fertilization on the uptake and accumulation of potassium by the component organs of the sugarcane plant were analyzed under conditions of sand nutrient and soil cultures, respectively.

Phosphorus deficiency raised the quantity of potassium in dry matter during certain critical periods of 45, 135, and 225 days, but did not alter the  $K_2O$  content at other stages.

Phosphorus fertilization up to a critical limit of 20 p.p.m.  $P_2O_5$  in the soil increased the  $K_2O$  content of the tissues but further additions were ineffective in altering the percentage of potassium.

Potassium accumulated to a maximum extent in stem dry matter in both sand nutrient and soil cultures. The possibility of stem acting like a sink for a rapid accumulation of potassium has been indicated.

Age showed the most outstanding effect on potassium intake and accumulation. In the earlier juvenile stage, sugarcane invariably accumulated a larger amount of potassium in dry matter in comparison to the quantity accumulated at later stages of adolescence and presenescence.

Phosphorus deficiency resulted in poor potassium uptake by the entire plant. Low (grams per plant) values under such conditions were invariably associated with poor growth and dry matter accumulation in the phosphorus deficient sugarcane plant.

Potassium appeared to be absorbed more or less uniformly at successive stages of the life cycle irrespective of the deficiency of phosphorus in the culture medium. When phosphates were applied in large amounts as in soil cultures, potassium accumulated in heavy quantities during adolescence and maturity.

Col. Agr., Banaras Hindu U., Banaras 5, India.

Estes, G. O., and Gausman, H. W. SOME EFFECTS OF SULFUR-MAGNESIUM RATIOS ON THE POTATO PLANT (SOLANUM TUBEROSUM). *Amer. Potato J.* 38: 43-50. 1961.

Greenhouse studies were conducted during 1958 and 1959 to determine the effect of various ratios of S to Mg on the growth and nutrient composition of Katahdin potato plants. Results from three crops indicated the following:

1. Additions of Mg and S did not increase plant height during the first crop. During the second and third crops, several S:Mg ratios such as 20:10, 30:20, and 30:30 significantly increased plant height.
2. Treatments significantly increased the dry weight only of the second crop. This increase in total dry weight of the plants was obtained with the 20:10 and 30:30 ratios of S to Mg.
3. Numbers of tubers per plant were significantly increased by either Mg or S and by the interaction of S with Mg. Considering the main effects of Mg and S, the greatest number of tubers was obtained with the 20 pound level of Mg, and the 10 and 20 pound level of S.
4. Magnesium additions significantly increased the nitrogen content of the plants. The interaction of S with Mg significantly reduced the  $PO_4$  level of the plants.
5. Uptake by leaflets of potato plants from soil application of S-35 was influenced by S to Mg treatments. A uniform distribution of S-35 occurred in leaflets of plants receiving an even ratio of S to Mg. A ratio of S to Mg such as 0:30 resulted in an uneven distribution of S-35 in the leaflets.

6. Several of the nutrient components of the plant tops were significantly correlated. In this respect, positive correlations occurred between Mg and N, and Mg and K. Negative correlations occurred between Cl and  $\text{PO}_4$ , and K and Ca.

Jr. Author, Maine Agr. Expt. Sta., Orono, Maine.

Spencer, W. F., and Wander, I. W. A COMPARISON OF MAGNESIUM SOURCES FOR YOUNG ORANGE TREES. Fla. State Hort. Soc. Proc. 73: 28-35. 1960.

Four sources of magnesium--sea water magnesia, Emjeo, olivine, and dolomite--were compared at three rates of application to young Valencia and Pineapple orange trees growing on previously unlimed, virgin Lakeland fs. Two relatively insoluble sources of magnesium, dolomite, and olivine were applied at two rates broadcast with no additional magnesium in the fertilizer. Tree growth was not affected by differential rates or sources of magnesium. Under the conditions of this experiment, sea water magnesia was the best source of magnesium, closely followed by Emjeo. Dolomite was somewhat less available than Emjeo. Olivine proved to be a relatively poor source of magnesium.

Dolomite applied at the rate of 2,340 pounds per acre broadcast with no additional fertilizer magnesium appeared to be sufficient as the only magnesium supply for the first 7 years of growth in the field. This treatment resulted in no magnesium deficiency symptoms until the sixth year, and very few symptoms during this relatively heavy crop year.

The leaf magnesium content and magnesium deficiency symptoms indicated that a leaf level of 0.33 percent Mg in July would result in no magnesium deficiency symptoms during that crop year, even though no additional magnesium were applied subsequent to the leaf sampling.

Fla. Citrus Expt. Sta., Lake Alfred, Fla.

Metzer, R. B., Johnson, S. P., and Coffey, L. C. EFFECTS OF CALCIUM TREATMENT ON THE QUALITY OF COTTON SEED. Agron. J. 53: 316-319. 1961.

Deterioration of cotton seed due to different amounts of rainfall prior to harvest was counteracted by treating seed with calcium (hydrated lime). Calcium-treated seed of varying stages of deterioration produced seedlings that were more healthy and vigorous than those from untreated seed. Slightly to moderately deteriorated seed tended to be less responsive to calcium treatment than highly deteriorated seed. During storage, calcium-treated seed had slightly lower moisture content than untreated seed.

Tex. Agr. Expt. Sta., College Station, Tex.

Karim, A. Q. M. B., and Deraz, O. EFFECTS OF MICRONUTRIENTS ON THE ABSORPTION OF MAJOR ELEMENTS IN MUSTARD. Soil Sci. 92: 408-412. 1961.

A soil sample was collected and properly processed in the laboratory. The soil was then fertilized with N-P-K fertilizers. Micronutrients (B, Mo, Mn, and Cu) at three different rates were separately applied and thoroughly mixed with the soil. Mustard seeds were finally sown in these soils in glazed earthen pots. From the date of germination of the seeds the plants were allowed to grow undisturbed for about a month. Thereafter plant samples were collected at four different stages of growth and carefully washed and dried at  $105^{\circ}\text{C}$ . in the

electric oven. N, P, K, Ca, and Mg were then determined in these samples. Finally, the stimulating effects of B, Mo, Mn, and Cu on the absorption of N, P, K, Ca, and Mg were compared. The application of Mo was found to stimulate considerably the absorption of N, K, and Ca and, to a lesser extent, P and Mg. Thus, Mo gave the best growth and the highest yield of seeds of all the micronutrients under examination. In comparison, B was next to Mo in stimulating the absorption of N, K, Ca, and P, but B did not show any clear effect on the absorption of Mg.

Mn increased the absorption of K, Ca, and Mg, but its effect on the absorption of N and P was not clear. Similarly, Cu stimulated considerably the absorption of N and K but did not show any clear influence on the absorption of P, Ca, and Mg. As a result of such unbalanced nutrition under the stimulation of Mn and Cu, general growth of the plant suffered.

Dacca U., Dacca, East Pakistan.

Mokragnatz, M., and Filipovic, Z. FURTHER EVIDENCE OF THE INFLUENCE OF SOIL pH ON COBALT CONTENTS OF GRASSES. *Soil Sci.* 2: 127-128. 1961.

In an investigation of the cobalt content of soil and grass in eight Yugoslav pastures, it was found that there is no direct connection between the cobalt content of grass and that of soil, but that there is, apparently, a close connection between cobalt in grass and soil pH, thus confirming opinion that soil reaction constitutes one of the important factors that regulate plant uptake of cobalt.

Pharmaceutics, Faculty, Inst. Chem., Belgrade, Yugoslavia.

Jeffrys, R. A., Hale, V. Q., and Wallace, A. UPTAKE AND TRANSLOCATION IN PLANTS OF LABELED IRON AND LABELED CHELATING AGENTS. *Soil Sci.* 92: 268-273. 1961.

Several studies were made to evaluate the relative accumulation and translocation of Fe vs. chelating agents by plants. The Fe-59/EDDHA ratio in bush beans increased up to 11 days. The pH of nutrient solutions was found to be an important factor in determining the relative amount of Fe and EDDHA (ethylenediamine di (o-hydroxyphenyl acetate) accumulated in plants. At pH 4 the Fe greatly exceeded EDDHA in plants; at pH 7 the two components were essentially equal; and at pH 8.5 the EDDHA exceeded the Fe. Plants grown in a slightly acid soil had ratios corresponding to the pH 7 solution. Increasing Fe levels resulted in moderate increases in Fe/EDDHA ratios in sunflower. Metabolic inhibitors decreased the accumulation in Fe much more than EDDHA. EDDHA and DTPA (diethylene-triamine pentaacetic acid) caused Fe-59 from a previous treatment to be translocated from roots to leaves. A pre-treatment of EDDHA resulted increased Fe-59 movement to leaves.

U. Calif., Los Angeles, Calif.

Nielsen, K. F., Halstead, R. L., MacLean, A. J., Bourget, S. J., and Holmes, R. M. THE INFLUENCE OF SOIL TEMPERATURE ON THE GROWTH AND MINERAL COMPOSITION OF CORN, BROMEGRASS AND POTATOES. *Soil Sci. Soc. Amer. Proc.* 25: 369-372. 1961.

When grown with different nutrient treatments in temperature-controlled soil in the greenhouse, yields of corn and bromegrass tops increased with increments in temperature

from 41° to 80° F., but yields of potato tops and tubers showed a less consistent relationship with temperature. Yields of corn and bromegrass roots also increased with temperature except for a decline in bromegrass roots when temperature was increased from 67° to 80° F. Tuber yields were usually higher at soil temperature above 41° F., but the optimum temperature varied with nutrient treatment.

The nutrient composition of the crops showed few consistent trends in relation to soil temperature. The P content of bromegrass and potato tops, however, increased with rising temperatures when the plants were grown without added P. Uptake of N, P, Ca, Mg, and K by the crops usually increased with increased temperature to at least 67° F. The uptake of P by the plants without addition of the nutrient, relative to the uptake obtained with addition, increased almost invariably with each increment in temperature. Water-use efficiency usually increased where N, P, and K were added together and often decreased as soil temperature increased.

<sup>1</sup> Soil Res. Inst., Res. Br., Canada Dept. Agr., Ottawa, Ontario, Canada.

Williamson, E. B., and Riley, J. A. INTERRELATED EFFECTS OF DEFOLIATION, WEATHER AND MECHANICAL PICKING ON COTTON QUALITY. *Trans. ASAE* 4: 164-165, 169. 1961.

The success of a quality cotton harvesting program in humid areas depends largely on the combined efficiency of defoliation, picker performance, and timing. Optimum harvesting procedures can preserve quality, but in too many cases in humid areas especially, improper harvesting robs cotton lint of some of its inherent desirable characteristics. Recent basic studies of moisture relationships revealed a high correlation between relative humidity, field seed cotton moisture, and the moisture content of seed cotton picked with high and low rates of spindle moisture. Furthermore, leaf cover was found to be one of the main controls over relative humidity within the environs of the cotton plant. The key to a quality harvest is timing. Seasonally, defoliants must be applied on a date that will balance the quality of an early harvest with the quantity of a late harvest. Daily, the pickers must operate during the hours of correct seed cotton moisture content in order to minimize staining, moisture, and trash problems. The correct timing of these two operations will make defoliation and picking most effective and will in turn preserve the many inherent desirable qualities of the harvested lint.

AERD, ARS, USDA, Stoneville, Miss.

Hamilton, J. W. NATIVE CLOVERS AND THEIR CHEMICAL COMPOSITION. *J. Range Mangt.* 14: 327-331. 1961.

Samples of Andean, whiproot, hollyleaf, Hayden, longstalk, dwarf, and Parry clovers were collected from numerous areas two or more successive seasons. The chemical composition of these clovers, i.e., carotene, ash, crude fiber, nitrogen-free extract, calcium, phosphorus, and magnesium, was determined. The levels of these components present in the clover samples varied within rather wide limits, but in nearly all samples the levels present indicated their high nutritional qualities. Parry and hollyleaf clovers contained the highest levels of carotene. Individual clover samples in Wyoming and near the Stateline in southern Montana, contained widely varying levels of ash. Whiproot, Parry, and longstalk had the lowest mean ash content of those studied. The crude protein levels of Hayden and Parry clovers were highest, being above 23 percent.

Ether-extract and nitrogen-free extract levels in the native clovers compared favorably with the level of these components found in white, alsike, and red clovers. The crude-fiber contents of the individual clover samples were quite variable. Parry, hollyleaf, dwarf, and Hayden clovers contained the lowest mean crude-fiber contents.

The calcium contents of all samples of Parry, hollyleaf, and Andean clovers collected from certain areas were greater than 3.80 percent. Whiproot and dwarf clovers growing with Parry clover contained a much lower level of calcium than did Parry. Longstalk clover contained a much lower mean level of calcium than did the other native clovers studied.

Considerable variations existed between the phosphorus content of the individual samples. Only slight differences existed between the mean phosphorus values for all groups reported, except for dwarf and Andean clovers, which were somewhat lower. The phosphorus levels of hollyleaf and Andean clover collected at seed stage were somewhat lower, as would be expected.

The magnesium contents of the individual clover samples varied over a considerable range. Samples of Parry clover, growing on soil derived from dolomitic limestone, contained levels of magnesium much higher than samples of the same clover from other areas or samples of whiproot clover from the same location. Dwarf clover from two locations contained a high level of magnesium.

U. Wyo., Laramie, Wyo.

Sharples, G. C., Kuykendall, J. R., True, L. F., and Tate, H. F. IMPROVEMENT OF MARKET QUALITY OF CARDINAL GRAPE BY INFLORESCENCE APEX REMOVAL. Proc. Amer. Soc. for Hort. Sci. 77: 316-321. 1961.

The market quality of Cardinal grape clusters were greatly improved by clipping off about 1 cm. (3/8 inch) or less, depending on length, from the inflorescence apex immediately before blossoming began. The treatment resulted in clusters which ripened earlier, had more uniform color, and perhaps more normal seeded berries, especially on the shoulders, which could account for improved cluster shape. Inflorescence apex removal tended to reduce total yield but not significantly. Associated with grade improvement was a slight increase in berry size, and a reduction in number of shotberries in early ripening clusters.

U. Ariz. Agr. Expt. Sta., Tucson, Ariz.

Gardner, F. P., and Wiggans, S. C. YIELD, MOISTURE, AND PROTEIN COMPOSITION OF SPRING OATS CUT FOR SILAGE AT DIFFERENT STAGES OF MATURITY. Agron. J. 53: 251-254. 1961.

The effect of variety and stage of maturity on yield and other properties of oats cut for silage was studied at Ames, Iowa, during 1956-59. For the 4-year test, forage yields (68% moisture) at the boot, heading, milk, early-dough, and late-dough stages were 4.91 to 6.38, 9.40, 11.09, and 11.81 tons per acre, respectively. The grain portion of the silage was 0, 0, 22, 27, and 33% at these respective stages. Dry-matter production was at a mean rate of 167 to 196 pounds per acre per day from June 1 (boot stage) to July 5 (late-dough stage) in a moist year without lodging, but was only 83 pounds per acre per day in a dry year. Maximum production of oat forage was obtained at the early-dough stage in a year with severe lodging.

Garry, a tall late variety, generally produced more oat forage than Andrew, Mo. 0-205, and Newton, three midseason varieties, in 1956-58; but Newton tended to be the most productive in 1959. A significant variety X maturity stage interaction was noted in 1958 and 1959, probably due to greater disease injury to Garry in the advanced stages of growth.

The 4-year mean moisture percentage of the oat forage was 85.5, 81.7, 75.2, 70.6, and 61.2% at the boot, heading, milk, early-dough, and late-dough stages, respectively. The moisture percentage of the grain was less than for the whole plant. Garry and Newton varieties were higher in moisture than Andrews and Mo. 0-205 at comparable stages of maturity.

The mean protein percentages at boot, heading, milk, early-dough, and late-dough stages were 14.4, 12.7, 11.0, 9.9, and 9.2 respectively. The protein content was higher and, after the milk stage, decreased less rapidly in a dry than in a wet year.

Alfalfa hay yield following oats cut for silage was not affected significantly by stage of harvest or variety of the oat companion crop.

CRD, ARS, USDA, Burns, Oreg.

Smith, C. L., Harris, O. W., and Hammar, H. E. COMPARATIVE EFFECTS OF CLEAN CULTIVATION AND SOD ON TREE GROWTH, YIELD, NUT QUALITY, AND LEAF COMPOSITION OF PECAN. Proc. Amer. Soc. for Hort. Sci. 75: 313-321. 1960.

The yields of Schley and Success pecan trees growing in Dallis grass sod with annual applications of 500 pounds of 6-0-0- or 6-8-6 fertilizer per acre were lower than those of similar trees cultivated in summer but with winter-legume cover crops turned into the soil each spring and with or without annual applications of 500 pounds of 6-8-6 fertilizer per acre. The yields of the Success variety were affected by the sod to a greater extent than were those of the Schley, probably because of the relatively smaller crops on the Schley during this period. The tree growth of both varieties was retarded to about the same extent by the sod, but after winter-legume cover crops were introduced into the Dallis grass sod treatments and the nitrogen added by these crops became available to the trees (1 year after the first legume cover crop was produced) the yields of nuts per square foot of trunk cross section were about the same for trees in all treatments.

Much slower growth was made by the trees in sod until the soil nitrogen supply became adequate, after which the trees in all treatments grew at approximately the same relative rate and the yields of nuts per unit of trunk cross section were about the same. However, the larger trees produced more nuts per tree, and thus greater yields per acre than did the small trees. Therefore, the effect of the Dallis grass sod without adequate nitrogen for both trees and grass was to retard growth of trees and to lower the yields, but with adequate nitrogen the sod had no apparent effect on either. Since the trees in all treatments were of the same age at the beginning of the experiment, and since their growth during the experiment was controlled largely by the supply of nitrogen, the sizes of the smaller trees at the beginning of the experiment with their consequent lower yield potentials were the result of inadequate supplies of soil nitrogen in some previous years.

Except for the first 2 years of the experiment the phosphorus content of the leaves of trees in all treatments was relatively high in years of low crops, and relatively low in years of heavier crops. The larger crops may have used more phosphorus in the synthesis of proteins in nut development. After the first 2 years the phosphorus content of leaves of trees growing in sod was higher than that of leaves of cultivated trees and the differences were statistically significant in most years. No explanation of these differences is available.

There were no consistent relations between the potassium content of the pecan leaves and the calcium or the magnesium contents. However, calcium and magnesium fluctuated in the same direction each season and the curves for percentages of these elements were more or less parallel. There were no apparent effects of cultural treatments or fertilizers on the amounts of potassium, calcium, or magnesium in the leaves.

ARS, USDA, Shreveport, La.

Wilks, J. M., and Stewart, J. A. RESPONSE OF LITTLE CHERRY-INFECTED CHERRY TREES TO ZINC TREATMENTS. *Canad. J. Plant Sci.* 41: 517-523. 1961.

In the Creston Valley of British Columbia, mature Lambert cherry trees displaying severe symptoms of the virus disease little cherry were treated with various zinc carriers applied to the soil, to the dormant wood, or to the foliage. The trees had not shown the chlorotic symptoms typical of zinc deficiency but had produced fruits and leaves that were smaller than might be expected from the virus infection alone.

The zinc treatments invariably resulted in improvements in leaf size, and especially in fruit quality. The best zinc treatment gave increases of 59 percent in fruit size and 77 percent in soluble solids content. The most marked responses were obtained with zinc sulphate applied as a dormant spray or with ZnEDTA chelate applied to the soil. Foliar sprays were the least effective. The quality of zinc present in the leaves collected from treated plots showed no association with observed fruit responses. Leaf analyses demonstrated that a mild zinc deficiency condition existed. These trials indicate that the quality of fruits on trees infected with little cherry virus may be adversely affected by zinc deficiency, in the absence of recognizable zinc deficiency symptoms.

Canada Dept. Agr., Summerland, British Columbia, Canada.

Mortvedt, J. J., Fleischfresser, M. H., Berger, K. C., and Darling, H. M. THE RELATION OF SOLUBLE MANGANESE TO THE INCIDENCE OF COMMON SCAB IN POTATOES, *Amer. Potato J.* 38: 95-100. 1961.

The incidence of potato scab was significantly reduced by the addition of soluble manganese added to quartz sand in the tuber forming zone of Chippewa potatoes in two green-house experiments. Specially designed wooden boxes were constructed enabling the tuber setting zone to be separated and treated differently from the roots. The roots were placed in glazed crocks containing complete nutrient solutions.

Cultures of *Streptomyces scabies* were suspended in various manganese solutions, mixed with quartz sand, and placed in the tuber forming region. In both experiments, the development of scab was significantly reduced by concentrations greater than 2.0 p.p.m. soluble manganese.

Three levels of manganese sulfate were row applied with the fertilizer to Red Warba potatoes at planting time in a field experiment. The yield and scab index of the potatoes were not significantly changed by any of the treatments. Chemical analysis of the top growth indicated that the manganese content of the tissue was increased in the treatments where manganese had been added. This increase was evident before blossoming and the initial formation of tubers. Analyses of the tubers showed that the addition of manganese to the applied fertilizer caused increases in the manganese content of the tuber epidermal tissue, but had no effect on that of the tuber parenchyma tissue.

Although significant differences were not obtained in this field experiment, the trend was toward reduced scab with higher manganese applications.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

### Soil Classification

Weaver, J. E. THE LIVING NETWORK IN PRAIRIE SOILS. *Bot. Gazette* 123: 16-28. 1961.

Interrelations of prairie soils and the living network of roots within them were examined. Grassland soils contain and act upon a more extensive portion of prairie plants

than does the atmosphere. In the large area of midcontinental grasslands in western Iowa, and eastern Nebraska and Kansas, the parent materials are wind-blown loess and glacial drift. Prairie vegetation, following or accompanying physical weathering, introduced the biological force which was largely responsible for constructional processes in the soil. The accumulation of organic matter, mostly from vegetation, in the A horizon was a major factor in soil formation in both Brunizem and Chernozem soils.

In Brunizems, the A horizon of dark-brown loam or silty clay loam is 8-16 inches thick and the lighter colored clay loam or silty clay loam of the B horizon is 12-24 inches thick. Beneath these lies the pale-brown or light-yellow C horizon of parent materials from which these very productive soils have been formed. Roots of prairie plants penetrate entirely through the solum and deep into parent materials. The vegetation everywhere is associated with soils that are highly fertile because of the good supply of plant nutrient elements in the primary materials, an adequate amount of organic matter, and small amounts of leaching resulting from moderate (25-32 inches) precipitation.

The root networks of the most abundant bunch grasses of uplands were thoroughly examined. Andropogon scoparius is dominant over half of an area of 60,000 square miles, Stipa spartea and Sporobolus heterolepis form much smaller communities. Their root systems are similar in size, depth, and degree of branching. The many hundreds of roots per square foot, with their innumerable interwoven branches of great tensile strength, form a continuous network throughout the soil. In the surface foot alone, the dry weight of the root network is 2.7-4.4 tons per acre. The network becomes finer and more open with depth, but it is normally 5 feet deep and thus extends downward well into the parent materials.

The equally widespread network formed by taller, sod-forming, lowland dominants-- Andropogon gerardi, Spartina pectinata, and Panicum virgatum--is coarser, much heavier, and not so intricately branched. It continues much deeper, however, often to 8-10 feet, in these better watered soils.

The root system of each species of grass has certain inherent characteristics such as length, depth of penetration, and degree of proliferation, but these may be modified by soil conditions.

The root network of forbs supplements that of grasses and is especially conspicuous in the parent materials. On loess hills the roots of several grasses may extend 5-8 feet into the parent materials, but roots of many forbs have been shown to attain depths of 17-20 or more feet.

Many changes in parent materials result from the presence of roots. Pores and channels are formed which accelerate the entry of water and air and thus increase chemical erosion. Roots absorb water and nutrients and transport them upward through the soil. Nodules with nitrogen-fixing bacteria occur at all depths on roots of legumes. Hordes of organisms that live in the soil find entry along old root channels and cause decay. They too finally die and add to the considerable, well-distributed organic matter from decayed roots. Thus, soil development and plant growth are intimately related even in the C horizon.

U. Nebr., Lincoln, Nebr.

Wilding, L. P., and Westin, F. C. CHARACTERIZATION OF THE SINAI SOILS. *Soil Sci. Soc. Amer. Proc.* 25: 380-384. 1961.

The Sinai series comprises well-drained Chernozem soils developed in calcareous, finely stratified, glacio-lacustrine, silty clay loam, and silty clay sediments. These soils occupy the nearly level to gently sloping tops of mesalike hills interlaced with a more or less continuous, moatlike pattern of colluvial-alluvial drains and swales. The profile has some characteristics of youthful grumusols. It consists of a black, granular A<sub>1</sub> horizon;

dark grayish-brown or olive brown, prismatic-subangular blocky B<sub>2</sub> horizons; mottled light olive brown, prismatic B<sub>3ca</sub> horizons; and mottled light olive brown, laminated C<sub>ca</sub> or D<sub>ca</sub> horizons. Many vertical, dark-colored tongues of A<sub>1</sub> material extend into the B<sub>3ca</sub> horizons. Laboratory analyses of three profiles sampled in the northern, central, and southern areas of the Prairie Coteau of eastern South Dakota indicate that the northern samples contain greater quantities of organic carbon and total nitrogen than the southern samples. Field studies indicate that the southern soils have browner A<sub>p</sub> and B<sub>2</sub> horizons, and structural development to greater depths than the central or northern Sinai soils. These morphological and chemical differences are attributed to climatic and vegetative variations during their genesis.

Jr. Author, S. Dak. State Col., Brookings, S. Dak.

Buol, S. W., and Hole, F. D. SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION CLAY SKIN GENESIS IN WISCONSIN SOILS. *Soil Sci. Soc. Amer. Proc.* 25: 377-379. 1961.

Clay skins separated from the B<sub>3</sub> horizon of the "Ockley-like" sil, a Gray-Brown Podzolic soil, were further analyzed and found to contain 186% as much total phosphorous and 177% as much total manganese as the bulk of the same horizon. More than 200 thin sections were made of samples from a variety of Wisconsin soils, including soils of the Podzol, Gray-Brown Podzolic, Brunizem, and Humic-Gley great soil groups. A study of volume of clay skins, as determined from microscopic views of thin sections, and soluble salt concentration revealed that in the "Ockley-like" profile maxima of both occurred in the C<sub>1</sub> horizon. By alternately leaching with percolate from a leaching column and drying with a water aspirator, artificial clay skins were produced in "unweathered" loess material. A definition of the term "clay skin" is proposed and it is concluded that clay skins in Wisconsin soils are formed by the percolation of dilute clay suspension, from which clay is deposited at or below the bottom of the solum as percolation ceases and the larger pores are emptied of water.

Soil Survey Div., U. Wisc., Madison, Wisc.

Rieger, S., and Juve, R. L. SOIL DEVELOPMENT IN RECENT LOESS IN THE MATANUSKA VALLEY, ALASKA. *Soil Sci. Soc. Amer. Proc.* 25: 243-248. 1961.

Most well-drained soils in the Matanuska Valley, Alaska, are developing in loess which is still being deposited. In deep loess close to the river floodplains that are its source, the soils are Regosols. Farther from the floodplains, in shallower loess, soils are Regosol-Podzol intergrades, and, at still greater distances, they are Podzols. In the Regosols, it is likely that the rate of accretion of loess exceeds the rate of horizon differentiation, but in more distant areas with a lower rate of dust accumulation podzolization can proceed. There are indications of development of more distinct Podzols in both the Regosols and Regosol-Podzol intergrades at an earlier time during a pause or reduction in rate of loess deposition. There is evidence of incipient podzolization even in the Regosols at the present time.

SCS, USDA, Palmer, Alaska.

The origin of a loamy surficial deposit within the soils of Sols Bruns Acides on glacial till in an area adjacent to the Adirondack Mountains of New York was investigated by field studies, mechanical analysis, and microscopic study. Field criteria strongly support an eolian origin, but cumulative particle-size curves are unlike those of typical loess. Both cumulative curves and degree of grain frosting resemble mixtures of material from silty lacustrine deposits and glacial till in the same area. It was concluded that the surficial deposits are mixtures of fines from nearby areas of glacial till and lake sediments transported partly by saltation and partly by suspension through wind action.

Jr. Author, N. Y. State Col. Agr., Cornell U., Ithaca, N.Y.

Wenner, K. A., Holowaychuk, N., and Schafer, G. M. CHANGES IN THE CLAY CONTENT, CALCIUM CARBONATE EQUIVALENT, AND CALCIUM/MAGNESIUM RATIO WITH DEPTH IN PARENT MATERIALS OF SOILS DERIVED FROM CALCAREOUS TILL OF WISCONSIN AGE. *Soil Sci. Soc. Amer. Proc.* 25: 312-316. 1961.

Several depth samplings of parent materials (medium and moderately fine-textured calcareous till) of each of 42 soil profiles were analyzed for clay content,  $\text{CaCO}_3$  equivalent, and the quantities of Ca and Mg extractable with acid.

The vertical distribution of the clay content, the  $\text{CaCO}_3$  equivalent and the Ca/Mg ratios indicate that the upper 24 to 30 inches of the calcareous material has been altered appreciably and should be considered part of the solum. The clay distribution shows a concentration of clay in a zone of partial leaching. The Ca/Mg ratios for each soil show that Ca leaches more readily than the Mg in calcareous materials. The depth below which there was no variation of the three properties was not reached in the sampling depths employed. These three properties, however, reach fairly uniform values below about the 30-inch depth. To properly characterize parent materials of soils derived from calcareous Wisconsin till, samples must be taken at least 30 inches below the initial point of effervescence.

SCS, USDA, Delaware, Ohio.

Karpachevskiy, L. O. MICROMORPHOLOGICAL STUDY OF LEACHING AND PODZOLIZATION OF SOILS IN A FOREST. *Soviet Soil Sci.* 5: 493-500. May 1960.

In a study of leaching and podzolization of forest soils, the author reached the following conclusions:

1. Colloids forming during the process of podzolization are carried downward by water into the lower horizon. They include  $\text{Fe}$  and  $\text{SiO}_2$  colloids in the form of hydrosols under the protection of humus soils.
2. The nature of the movement and deposition of colloids depends on soil texture. In sandy soil, colloids precipitate in the form of films around minerals and in the form of accumulations in the spaces between the grains. In clay loam soils, colloids move mostly through pores, so that oriented colloids form scaly films, concentric stratifications in pores, and diffuse streaks and spots.
3. The removal of colloids into the illuvial horizon changes the oxidation-reduction conditions in the profile of soils toward reduction, especially in the illuvial horizon, which leads to their dehydration and a change in their mineral composition.

4. The orientation of mineral colloids is observed in plant tissue.
5. All this leads to the conclusion that the previously described soils colloids are moved by water flow. Podzolization is accompanied by the intensification of the weathering of primary minerals, while leaching, or lessivage, is the initial phase of podzolization and the accompanying process during the latter phases of podzolization. There may be no substantial differences in the composition of secondary minerals, as long as the oxidation-reduction conditions in the soil profile are of the same type. However, during the development of the process of leaching of colloids new minerals are formed in the illuvial horizon.

Amer. Inst. Biol. Sci., 2000 P St., N.W., Washington, 6, D.C.

Sandoval, F. M., and Shoesmith, L. GENETIC SOIL RELATIONSHIPS IN A SALINE GLACIO-LACUSTRINE AREA. *Soil Sci. Soc. Amer. Proc.* 25: 316-320. 1961.

A genetic approach supported by laboratory studies was used as a technique in diagnosing a saline soil problem in North Dakota. Depths to 12 feet were studied. Soils of most of the area (saline phases of Bearden and Glyndon series) have silt loam or silty clay loam surfaces, and are derived from thick lacustrine sediments. Magnesium usually was the dominant cation, followed by sodium. Most common horizon sequence in lacustrine areas was: A<sub>1</sub>, A<sub>ca</sub>, C<sub>ca</sub>, C, C<sub>g</sub>, and G. A lesser acreage of shallow lake-washed or reworked materials over firm calcareous clay loam glacial till assumed importance because of higher elevation physiography and a closer chemical relationship to saline waters under artesian pressure from the underlying Dakota Sandstone geologic formation. Where till was closer to the surface, the horizon sequence was: A<sub>1</sub>, A<sub>ca</sub>, C<sub>ca</sub>, C, C<sub>g</sub>, D or D<sub>g</sub>, and G, with frequent absence of C layers depending upon depth to till.

Chemical differences between lacustrine and till areas are attributed to genetic differences, i.e., the fine-textured lacustrine sediments themselves appear high in Mg-bearing materials. These saline, hydromorphic, imperfectly drained soils were classed as calcareous solonchaks.

SWCRD, ARS, USDA, Mandan, N. Dak.

White, E. M. CALCIUM-SOLODI OR PLANOSOL GENESIS FROM SOLODIZED-SOLONETZ. *Soil Sci.* 91: 175-177. 1961.

Solonetzic soils with thin A<sub>1</sub>-A<sub>2</sub> and columnar, textural, B horizons, but with vegetation superior to that of thin-surfaced solodized-solonetz, occur in southwest central South Dakota. Less than 10 percent of the exchangeable cations in the upper B horizon are sodium. Calcium from carbonates apparently replaces exchangeable sodium, so that the soil will not degrade to a solod but will develop planosolic characteristics.

S. Dak. State Col., Agr. Expt. Sta., Brookings, S. Dak.

White, E. M., and Papendick, R. I. LITHOSOLIC SOLODIZED-SOLONETZ SOILS IN SOUTHWESTERN SOUTH DAKOTA. *Soil Sci. Soc. Amer. Proc.* 25: 504-506. 1961.

Solonetzic soils with thin calcareous sola occur in southwestern South Dakota. These profiles develop from sodium rich calcareous bedrock shortly after the bedrock is exposed

by erosion. Dispersion and column formation probably occur when most soluble salts are leached. However, there is some  $\text{Na}_2\text{CO}_3$  and the pH is high so  $\text{CaCO}_3$  solubility is reduced. Chestnut soils evolve if there is sufficient mineral-bound Ca to replace the exchangeable Na. Otherwise, solodized-Solonet soils form without the aid of a fluctuating water table.

These intergrade soils are important from the scientific standpoint. They provide an explanation for the development of solodized-Solonet on steep slopes not having a high water table. Formation of the vesicular  $A_2$  and weakly developed columnar B horizons in calcareous profiles may aid in constructing hypotheses about the origin of these kinds of structure.

S. Dak. State Col., Brookings, S. Dak.

Gerard, C. J., Bloodworth, M. E., Burleson, C. A., and Cowley, W. R. HARDPAN FORMATION AS AFFECTED BY SOIL MOISTURE LOSS. *Soil Sci. Soc. Amer. Proc.* 25: 460-463. 1961.

A hypothesis based on laboratory investigations is proposed to explain hardpan conditions which occur in cultivated and virgin soils in the Lower Rio Grande Valley. Hardpan formation, as influenced by various soil and moisture treatments, was evaluated. The hardpans produced in the laboratory were not of the intensity of field hardpans but were characteristically similar to those found in the field. The penetrometer was particularly adapted for evaluating the influence of laboratory treatments on hardpan formation. Moisture loss by evaporation, after surface drying, appears to be an important factor in formation of hardpans. Laboratory findings indicate that tillage practices influence the rate of moisture loss which influences the depth and intensity of hardpan formation in certain soils.

Tex. Agr. Expt. Sta. Substation 15, Weslaco, Tex.

Graveland, D. N., and Lynch, D. L. DISTRIBUTION OF URONIDES AND POLYSACCHARIDES IN THE PROFILES OF A SOIL CATENA. *Soil Sci.* 91: 162-165. 1961.

Three soil profiles, representing different stages in the genesis of a solonetzic group, were studied to determine the distribution of polysaccharides and uronic acids in the various soil horizons.

The profiles used were the Beaverhills 1 (orthic), the Angus Ridge 1 (solod), and the Camrose 1 (solodized solonet). These profiles are all developed from glacial till in the Black Soil zone and represent different stages in the genesis of the solonetzic group of soils.

The carbohydrate carbon, as determined by anthrone and as a percent of total organic carbon, ranged from 6.4 to 7.2 percent in the  $A_1$  horizons and from 11.7 to 12.9 percent in the B horizons, and in all instances it increased with depth.

Uronic carbon as a percent of the total organic carbon ranged from 0.82 percent to 1.23 percent in the  $A_1$  horizons, 1.83 to 3.29 percent in the  $B_2$  horizons, and from 1.19 to 2.90 percent in the  $B_3$  horizons. A pretreatment with  $\text{NHF}-\text{HCl}$  resulted in an increased yield of uronic acids in all cases but one.

U. Alberta, Edmonton, Alberta, Canada.

Cox, F. R., Jr., and Hucheson, T. B., Jr. MORPHOLOGICAL AND CHEMICAL PROPERTIES OF IMPORTANT DEPRESSATIONAL SOILS OF LOWLANDS IN THE WESTERN COAL FIELD REGION, KENTUCKY. *Soil Sci. Soc. Amer. Proc.* 25: 236-239. 1961.

Morphological and certain chemical properties of Alligator, Sharkey, Patton, and Dekoven series found in the Western Coal Field region of Kentucky were determined and compared with available data from other areas. These series occur in depressional areas along the tributaries of the Ohio River and are derived from mixed sediments of sandstone, shale, loess, limestone, and glacial till origin. The data obtained for the Alligator, Sharkey, and Patton profiles sampled in Kentucky differ very little from similar data for these series sampled and studied in other States. Consequently, their classification appears to be justified. No data on the Dekoven series from other States were available for comparison.

Jr. Author, U. Ky., Lexington, Ky.

Bunting, B. T. THE ROLE OF SEEPAGE MOISTURE IN SOIL FORMATION, SLOPE DEVELOPMENT AND STREAM INITIATION. *Amer. J. Sci.* 259: 503-518. 1961.

Field study of the podsolized soils and the drainage of an escarpment of Chatsworth gritstone (upper Namurian) in Northern England has suggested hypotheses relating to stream initiation and crestral development.

Moisture moving from crests over dip slopes of less than 5° becomes concentrated in narrow lines of relatively deep soil of distinctive phase. These lines are termed "seepage lines" and form a dendritic pattern linked directly to visible lines. Colluvium has gathered in certain depressions at the head of visible scarp and dip streams, and corrosion of the underlying bedrock, by accumulated seepage moisture, is taking place at depth. This corrosion of bedrock in seepage hollows is considered to be a major factor in the headward extension of first-order streams.

Moisture accumulation on crestral areas is limited so that corrosion and soil formation take place but slowly, or not at all, at least under present conditions. A crestral rock platform is thus preserved, with rock bastions or "tors" located upon it, the heights of which represent the thickness of material removed from the adjacent slopes by a combination of periglacial mass-wasting and postglacial surface and subsurface denudation.

Detailed studies of the soil mantle on such low-angle slopes on a uniform bedrock material have failed to establish any simple relationship of soil depth, profile, or texture with degree of slope or facet type. Position on the total slope in relation to the seepage net and indirectly to the drainage net is the most significant factor in soil formation and hence in slope development and denudation.

Birbeck, Col., U. London, London, England.

Fries, M., Wright, H. E., Jr., and Rubin, M. A LATE WISCONSIN BURIED PEAT AT NORTH BRANCH, MINNESOTA. *Amer. J. Sci.* 259: 679-693. 1961.

At North Branch, Minn., peat began to accumulate after the Grantsburg lobe (Mankato substage) started to retreat. The radiocarbon dates on the peat and its contained wood (12,700 and 12,030 B.P.) indicate that the Mankato substage preceded the Two Creeks interstadial rather than followed it. The peat was thus formed during the early part of the Two Creeks interstadial. The pollen and macrofossils from the peat suggest a landscape marked by sedge swamps and probably spruce-tamarack swamps on a broad river floodplain,

bounded by oak and ash and prairielike communities on upland sites. The climate seems to have been only slightly colder than today and probably drier.

The peat is overlain by sand that contains involuted layers of silt or clay rich in organic matter. These organic layers are believed to have formed as normal fine-grained sediment in quiet water. The pollen analysis indicates a vegetation dominated by pine and oak, typical of the postglacial. A radiocarbon date of 2520 B.P. for the upper part of the series of organic layers confirms the postglacial correlation. The folding of the layers into involutions must, therefore, have been produced without the aid of a permafrost base and may have resulted from localized annual frost connected with tussock growth of plants.

Jr. Author, U.S. Geological Survey, Washington, D.C.

Cooke, F. PROBLEMS OF PEAT: ACHIEVEMENTS OF THE IRISH PEATLAND RESEARCH STATION. *World Crops* 13: 381-384. 1961.

A report on a tour of the Peatland Experimental Station of Glenamoy, Ireland is given. The station was started in August 1955 and the experimental program is designed to determine the best and cheapest method of reclaiming and fertilizing bogland and the most suitable crops to be grown.

The investigations in progress fall into five groups: (1) Drainage experiments; (2) pilot experimental farm; (3) crop husbandry and grassland establishment; (4) livestock experiments; and (5) horticultural and industrial crops and trees.

To overcome the disadvantages of open drains a remarkable mole plow has been developed which produces in one operation a covered subsoil drain, called a tunnel drain, with the spoil evenly spread over the land. These drains are cut at 12-ft. intervals. After this operation the broken but level ground is in a condition ready for immediate over-seeding and fertilizing. The area is divided up into fields by large open drains at 200-ft. intervals into which the numerous mole drains deliver water continuously.

Experiments are in progress to assess the optimum frequency and depth of drains for various crops. This is also designed to assess the effect of cropping, manuring, and cultural treatments on the reclamation of peat for agricultural purposes.

No address given.

Rybtssov, D. M. PODZOLIC-BOG SOILS. *Soviet Soil Sci.* 7: 705-714. July 1960.

In a study of podzolic-bog soils in Russia the author made the following conclusions: (1) Peaty podzolic gley-like soils represent the initial bog stage of gleyed-podzolic soils of the northern taiga. Peat podzolic gleyed soils are the next bog stage. (2) The clay loam podzolic-bog soils described form under the influence of atmospheric wetting without the participation of ground water. (3) During the transition from peaty podzolic gley-like soils to peat podzolic gleyed soils the thickness of peat increases and the intensity and depth of gleyzation increase. With respect to chemistry, the humus content decreases, while its mobility increases. Mobile iron accumulates and exchangeable and hydrolytic acidities increase in the litter. (4) During the transition from peaty podzolic gley-like to peat podzolic gleyed soils, the podzolization process weakens even though the gleyzation process becomes more intense. And (5) from the zonal point of view, the process of podzolization in podzolic-bog soils tends to diminish from the southern sub-zone of the taiga to the northern and extreme north.

Amer. Inst. Biol. Sci., 2000 P St., N.W., Washington 6, D.C.

Gasser, J. K. R. INVESTIGATIONS ON RICE-GROWING IN BRITISH GUIANA: I. CHARACTERISTICS OF SOME RICE SOILS OF THE COASTLAND. *J. Soil Sci.* 12: 234-241. 1961.

An attempt was made to account for the different soil types derived from alluvial material of similar age and origin. The sequence noted was undifferentiated alluvium (frontland clay soil), humose clay (pegassy-clay soil), thin organic soils (pegasse). The subsoil varied from that similar to frontland clay to a bleached yellowish-white structureless clay. Differing durations and intensities of flooding were considered to be responsible for the changes in the subsoil. With permanent flooding, plant residues accumulate on the surface and the soil is more rapidly leached. Less organic matter accumulates and less leaching occurs with seasonal flooding. Reefs of dry sand and other soils develop under special conditions and, as they do not belong to the general sequence, are described separately.

Rothamsted Expt. Sta., Harpenden, Herts, England.

Fly, C. L. THE SOIL DRAINABILITY FACTOR IN LAND CLASSIFICATION. *J. Irrig. and Drain. Div. ASCE* 87 (IR 3): 47-62. Sept. 1961.

Several concepts of soil drainability related to land use capability were developed during the process of investigating and evaluating the irrigation development the soils and drainage characteristics of large land tracts in southwestern Afghanistan.

When the several components of land drainage were related to land use and irrigated land classification, the following two fairly constant and mathematically measurable factors were determined to be the more usable criteria of drainability: (1) Hydraulic conductivity and character of the saturated zone; and (2) the depth to very slowly permeable or impervious strata which act as barriers to the removal of groundwater. Most other drainage components are modifiable in one way or another by economic considerations, agronomic practices, or other influences, so that they do not remain constant and measurable except under arbitrarily defined limitations. A drainability rating method, based on hydraulic conductivity and barrier depths, was developed and successfully used in a major project development. It appears to be a useful concept to develop drainability rating guides for use in land classification or irrigated areas, or areas selected for development. Further research is needed to advance knowledge of the interrelationships of the various involved factors.

SWCRD, ARS, USDA, Fort Collins, Colo.

Erickson, R. A., and Paschall, A. H. MORPHOLOGY AND CLASSIFICATION OF CERTAIN SOILS IN EAST-CENTRAL MINNESOTA AND NORTHWESTERN WISCONSIN. *Soil Sci. Soc. Amer. Proc.* 25: 388-393. 1961.

A report on investigations made of soils on the northern and eastern periphery of the Grantsburg sublobe of the Des Moines loess (Mankato) located in east-central Minnesota and northwestern Wisconsin. Some of these soils are developed in Cary and post-Cary parent materials, ranging from sandy loam to silt loam in texture. Most of the profiles are developed in silts of varying thickness overlying tills of the Cary ground moraine. Modal profile descriptions are summarized. Selected physical and chemical characteristics are presented.

Silt covers most of the area, and the Grantsburg sublobe appears to be one source. The quantities of silt in the  $B_2$  horizons of the soils sampled along two traverses were greatest near the Grantsburg sublobe and became progressively less away from it and toward Shephard.

The present separation of soil series in the four catenas should be continued. One catena would include soils developed in brown sandy loam till. The Brainerd series is considered representative of this group, which is characterized by having the solum almost entirely in brown-colored till, a relatively high degree of base saturation, and little or no evidence of clay eluviation. A second catena represented by the Mora series have a sola almost entirely in reddish brown sandy loam till. The A horizon and a small portion of the B horizon may be developed in the silt mantle. The Mora soil has an intermediate base status and shows slight evidence of clay eluviation. The Freeon series represents the third catena. It has B horizons developed partly in the silt cap and partly in the underlying reddish brown till. It has an intermediate degree of base saturation and has evidence of clay eluviation. The fourth catena, represented by Spencer soils, has the entire sola developed in silt, but the soils are underlain by reddish brown till within depths of 4 feet. These soils have low to intermediate degree of base saturation and conclusive evidence of clay eluviation.

SCS, USDA, Fergus Falls, Minn.

Toogood, J. A. USE OF SOIL CORES IN SOIL CLASSIFICATION. *Canad. J. Soil Sci.* 41: 241-246. 1961.

The value of soil cores in soil classification was examined by a statistical study of the physical properties of five soil types, using a 3 x 3-inch soil cores. Analyses of variance when five replicates were used showed that field capacity differences of about 5 percent could be detected throughout the solum of these soils. Distinctions in volume weight and total porosity were readily made, significant differences ( $P=0.95$ ) being about 0.1 gram per cubic centimetre and 4 percent, respectively. Tension plate measurements were precise enough to show significant differences between some of the soils in the  $A_h$  horizon but between none in the  $B_t$  horizon.

It was concluded that in the classification of soils, it is relatively easy to demonstrate more differences in physical characteristics than are being published in most Canadian soil survey reports. The ease of demonstrating significant differences between certain horizons and soil types with respect to some physical properties justifies more extensive use of soil cores. More time is required in the field for sampling than for samples taken for chemical analysis, but this disadvantage is offset by shorter time required in the laboratory to complete the determination. Data for field capacity, volume weight, and total porosity are worthy of attention in the routine analysis of soil survey samples. Hydraulic conductivity and 60-centimetre porosity do not appear to be measured accurately enough to merit inclusion as routine procedure.

U. Alberta, Edmonton, Alberta, Canada.

Klingebiel, A. A., and Montgomery, P. H. LAND-CAPABILITY CLASSIFICATION. U.S. Dept. Agr., Agr. Hbk. 210, 21 pp. 1961.

The capability classification is one of a number of interpretive groupings made primarily for agricultural purposes. The capability classification begins with the individual soil-mapping units. In classification, the arable soils are grouped according to their potentialities and limitations for sustained production of the common cultivated crops that do not require specialized site conditioning or site treatment. Nonarable soils (soils unsuitable for longtime sustained use for cultivated crops) are grouped according to their potentialities and limitations for the production of permanent vegetation and according to their risks of soil damage if mismanaged.

The individual mapping units on soil maps show the location and extent of the different kinds of soil. One can make the greatest number of precise statements and predictions about the use and management of the individual mapping units shown on the soil map. The capability grouping of soils is designed to: (1) Help landowners and others use and interpret the soil maps; (2) introduce users to the detail of the soil map itself; and (3) make possible broad generalizations based on soil potentialities, limitations in use, and management problems.

The capability classification provides three major categories of soil groupings: (1) Capability unit; (2) capability subclass; and (3) capability class. The first category, capability unit, is a grouping of soils that have about the same responses to systems of management of common cultivated crops and pasture plants. Soils in any one capability unit are adapted to the same kinds of common cultivated and pasture plants and require similar alternative systems of management for these crops. Longtime estimated yields of adapted crops for individual soils within the unit under comparable management do not vary more than about 25 percent.

The second category, the subclass, is a grouping of capability units having similar kinds of limitations and hazards. Four general kinds of limitations or hazards are recognized: (1) Erosion hazard; (2) wetness; (3) rootingzone limitations; and (4) climate.

The third and broadest category in the capability classification places all the soils in eight capability classes. The risks of soil damage or limitations in use become progressively greater from class I to class VIII. Soils in the first four classes under good management are capable of producing adapted plants, such as forest trees or range plants, and the common cultivated crops and pasture plants. Soils in classes V, VI, and VII are suited to the use of adapted native plants. Some soils in classes V and VI are also capable of producing specialized crops under highly intensive management involving elaborate practices for soil and water conservation. Soils in class VIII do not return on-site benefits for inputs of management for crops, grasses, or trees without major reclamation. The grouping of soils into capability units, subclasses, and classes is done primarily on the basis of their capability to produce common cultivated crops and pasture plants without deterioration over a long period of time. To express suitability of the soils for range and woodland use, the soil-mapping units are grouped into range sites and woodland-suitability groups.

SCS, USDA, Inform. Div., Washington 25, D.C.

Bender, W. H. SOILS SUITABLE FOR SEPTIC-TANK FILTER FIELDS: A SOIL MAP CAN HELP YOU. U.S. Dept. Agr. Inform. B. 243, 12 pp. 1961.

Septic tanks have been used for sewage disposal by some farmers and suburbanites for several decades. The electrification of farms plus the rapid expansion of residential areas to rural communities have greatly accelerated the number of private sewage disposal systems now being installed.

The most satisfactory system usually has the sewer line leading to a septic tank in the yard with the overflow from the tank dispersed over a fairly large area through subsurface drain tile or perforated pipe. The tile or pipe may be laid in trenches or in a seepage bed. In either case, the septic tank and tile or pipe is covered with soil and planted to grass, and leaves no visible evidence of their existence.

Soils vary so much that it is not possible to give specific recommendations on the soils suitable for filter fields that would fit all localities. Before designing and constructing a private sewage disposal system, one should become familiar with the regulations, permit and inspection systems, and penalties of the local authority having jurisdiction over that area.

Obtain advice and planning aid from the city or county planning commission, local health department, agricultural extension specialist, or engineering and agricultural departments of colleges and universities, and State boards of health.

In addition to conforming with all local regulations, certain precautions should be taken for protection and convenience in selecting the site for the sewage filter field. Some of the more important things to consider are: (1) Soil permeability should be moderate to rapid, with a percolation rate of at least 1 inch per hour. (2) Ground water level, during the wettest season, should be at least 4 feet below the ground surface for a sub-surface tile filter field and 4 feet below the pit floor for a seepage pit. (3) Rock formations or other impervious layers should be more than 4 feet below the bottom of the trenches, seepage-bed floor, or pit floor. (4) Slope of the ground surface is not of great importance on slopes of less than 10 percent, but trench systems and seepage beds are difficult to lay out and construct on steeper slopes. Steep slopes underlain at shallow depths by rock or other impervious material sometimes present serious problems of seepage of septic-tank effluent to the soils surface. (5) Distance of streams or other water bodies should be at least 50 feet. Never install a filter field on a flood plain that is subject to flooding. (6) Changes in kind of soil within a filter field are important only if the soils differ greatly in absorptive ability. In such cases, run percolation tests for the entire field, and use serial distribution of the effluent. And (7) soil-survey reports and maps can help select a site where soil conditions are suitable for a sewage filter field.

SCS, USDA, Inform. Div., Washington 25, D.C.

O'Bannon, J. H., and Reynolds, H. W. ROOT-KNOT NEMATODE DAMAGE AND COTTON YIELDS IN RELATION TO CERTAIN SOIL PROPERTIES. *Soil Sci.* 92: 384-386. 1961.

Soil texture was an important factor affecting the relation between root-knot nematodes and cotton. The higher percentage of air present in coarse-textured soils (loamy sand and sandy loam) may readily contribute to the increase of root-knot nematode activity, and the greater pore size facilitates nematode movement. On soils with 50 percent or more sand, the nematodes increased very rapidly, and, because these soils are low in plant nutrients and organic matter, became a limiting factor in the growth of cotton. On soils containing less than 40 percent sand, the increase in the nematode population was appreciably less. Since these soils were also higher in organic matter content and retained higher nutritional levels, the nematodes did not become a limiting factor in the production of cotton.

Highly significant yield differences were obtained from fumigation of fields having loamy sands and sandy loam. With a medium-textured soil (silt loam) a significant yield difference was not obtained. Fine-textured soils (loams) are not favorable for root-knot nematode activity on cotton.

CRD, ARS, USDA, Tucson, Ariz.

Robinson, G. H., Devereux, R. E., and Obenshain, S. S. SOILS OF VIRGINIA. *Soil Sci.* 92: 129-142. 1961.

Detailed information on Virginia soils at the series level is available in soil keys, published soil survey bulletins, and research reports. General information relative to soil formation and the higher categories in classification, with some discussion of the chemical and mineralogical nature of the great soil groups is given. The generalized soil map shows the principal soil associations of the State, by physiographic divisions, and the distribution of each association.

Va. Agr. Expt. Sta., Blacksburg, Va.

## Soil Conservation Service. SOIL SURVEY:\*

*CALHOUN COUNTY, ALA.	U.S.D.A., S.C.S.	97 pp. Sept. 1961.
*BRADLEY COUNTY, ARK.	U.S.D.A., S.C.S.	66 pp. Apr. 1961.
*SAN MATEO AREA, CALIF.	U.S.D.A., S.C.S.	111 pp. May 1961.
*TROUT CREEK WATERSHED, COLO.	U.S.D.A., S.C.S.	48 pp. May 1961.
*GADSEN COUNTY, FLA.	U.S.D.A., S.C.S.	124 pp. Jan. 1961.
*DOUGLAS COUNTY, GA.	U.S.D.A., S.C.S.	85 pp. Nov. 1961.
*McINTOSH COUNTY, GA.	U.S.D.A., S.C.S.	62 pp. Dec. 1961.
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*LOUDON COUNTY, TENN.	U.S.D.A., S.C.S.	113 pp. June 1961.
*HASKELL COUNTY, TEX.	U.S.D.A., S.C.S.	74 pp. Mar. 1961.
*RAPPAHANNOCK COUNTY, VA.	U.S.D.A., S.C.S.	85 pp. Oct. 1961.
*JACKSON AND MASON COUNTIES, W. VA.	U.S.D.A., S.C.S.	92 pp. Oct. 1961.
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85 pp. Dec. 1961.

\*GRANT COUNTY, WIS.

U.S.D.A., S.C.S.

98 pp. June 1961.

All Soil Surveys are published by the United States Department of Agriculture, Soil Conservation Service in cooperation with the local state agriculture and/or other cooperating agencies. All contain maps in addition to the written text.

SCS, USDA, Inform. Div., Washington 25, D.C.

## EROSION CONTROL

### Erosion Equation

Agricultural Research Service. A UNIVERSAL EQUATION FOR MEASURING WIND EROSION: AN AID TO CONSERVATION FARMING IN THE GREAT PLAINS. U.S. Dept. Agr., Agr. Res. Serv. ARS 22-69. 20 pp. 1961.

Agricultural Research Service scientists have developed a wind erosion equation that is proving to be an important contribution to conservation farming in the Great Plains. The equation reflects the influence of the major factors known to affect wind erosion. Its usefulness in measuring a field's susceptibility to erode and for defining the practices needed to prevent erosion or to keep erosion from exceeding an insignificant rate have been established. It should ultimately take the guesswork out of conservation farming in the Great Plains by replacing generalized, observed estimates of field erodibility with quantitative measurements.

The equation is both useful and practical. Continuing research will result in refinements that will make the equation even more useful and versatile.

County agents and other agricultural leaders should consider this report both a reference and a tool--a reference that answers most of the questions usually asked about wind erosion and a tool for use in making erodibility evaluations or in demonstrating how they are made.

The new equation is as follows:  $E = IRKFCWDB$ , which is a symbolic way of saying that a field's susceptibility to erode depends on eight major factors:

1. The ratio between nonerodible and erodible soil aggregates--surface cover factor, I.
2. Whether the surface is bare or covered--surface cover factor, R.
3. How rough or smooth the surface is--ridge roughness equivalent factor, K.
4. The soil textural class or its inherent tendency to erode--soil abradability or stability factor, F.
5. Where the field is located geographically--wind velocity-surface soil moisture factor, C.
6. How wide the field is--field width factor, W.
7. How the field is oriented--wind direction factor, D.
8. Whether the field is protected by shelterbelts or tall stubble--the wind barrier factor, B.

The explanations, charts, map, and photographs are intended primarily for those agricultural leaders who will use the universal wind erosion equation in the field. Care should be taken to follow out-lined procedures as much as possible.

ARS, USDA, Inform. Div., Washington 25, D.C.

## Wind and Water Erosion

Bailey, R. W., and Copeland, O. L. VEGETATION AND ENGINEERING STRUCTURES IN FLOOD AND EROSION CONTROL. 13th Cong. International Union Forest Res. Organ., Vienna, Austria, Sept. 10-17, 1961. 23 pp. 1961.

Man's existence and economic well-being hinge upon his ability to live in harmony with the relentless forces of nature. Floods and soil erosion often are manifestations of a lack of harmony between man and his environment; this harmony must be reestablished if soil, water, vegetation resources, and man's culture itself are to be preserved. Flood and erosion phenomena with special emphasis on their causes and control are discussed. It deals primarily with the Intermountain region of the Western United States. The concepts and principles used in the analysis of flood and erosion problems and in the formulation of control programs in this area are basic to any program of erosion and flood control in which vegetation--forest or other--is to play an important part.

Vegetation is emphasized as the most efficient natural means of maintaining or restoring the norm of watershed hydrology and soil stability where it is determined that mismanagement of the lands or inadequate protection has resulted in accelerated flood occurrence and soil erosion.

In reestablishing the hydrologic norm of a watershed, revegetation and land management alone are often not enough to do the job but must be supplemented by engineering structures. Such engineering work must be integrated with plans for reforestation and revegetation. The role that forests can play in controlling floods and erosion rests primarily on the well-established concept that a fundamental relation exists between plant cover, soil stability, and streamflow. An understanding of the interrelatedness of the plants, animals, soil mantle, and water on forest lands is essential to the development and application of successful control measures. All vegetation--even low-growing, herbaceous plants--plays an important role in the reception and disposition of precipitation which falls on the watershed lands. Neglect of these hydrologic aspects of forest and range management has brought about floods and accelerated erosion in many parts of the world. Recognition of the functions performed by the soil and vegetation will be essential to the application of forest and range management to the prevention and control of floods and erosion.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Wallis, J. R. ERODIBILITY OF SOME CALIFORNIA WILDLAND SOILS RELATED TO THEIR METALLIC CATION EXCHANGE CAPACITY. *J. Geophysical Res.* 66: 1225-1230. 1961.

The inherent erodibility of 20 soils was indexed using Middleton's dispersion ratio and Anderson's surface-aggregation ratio. These indices were then used as dependent variables for several regression analyses. The milliequivalents per 100 grams of oven-dried soil for the four most plentiful soil cations (Ca, Mg, K, and Na) were determined and then used as independent variables in the regressions.

The best fit to the data was found to be an equation of the type:

$$\text{Erosion index} = a + b \left( \frac{\text{meq of}}{\text{Ca}^{++} + \text{Mg}^{++}} \right) + c \left( \frac{\text{meq of}}{\text{Ca}^{++} + \text{Mg}^{++}} \right)^2$$

Both the linear and the curvilinear terms were significant at the arbitrarily selected 5 percent level.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Whitaker, F. D., Jamison, V. C., and Thornton, J. F. RUNOFF AND EROSION LOSSES FROM MEXICO SILT LOAM IN RELATION TO FERTILIZATION AND OTHER MANAGEMENT PRACTICES. *Soil Sci. Soc. Amer. Proc.* 25: 401-403. 1961.

Results from the runoff-erosion plots on claypan soils at McCredie, Mo., are summarized. With improvement due to fertilization and sod rotations, the performance of these soils approaches that of the better soils of Missouri. Where adequate fertility is supplied, the chief advantage of growing corn in a sod-based rotation over continuous corn is the reduction in the time the soil is without protective cover. The critical period found for erosion losses from corn was from the time of seedbed preparation until the growing crop provided an adequate canopy. Erosion losses for rotation corn were about 60% as high as for continuous corn from intense rain storms that occurred during this period. Average soil and water losses from adequately fertilized soil were less for corn in rotation than for continuous corn during the corn growing season. Seedbed preparation by subtilage so as to leave shredded cornstalks on or near the surface reduced erosion losses.

SWCRD, ARS, USDA, Columbia, Mo.

Rich. L. R. SURFACE RUNOFF AND EROSION IN THE LOWER CHAPARRAL ZONE-ARIZONA. *Rocky Mountain Forest and Range Expt. Sta., Sta. Paper* 66, 35 pp. 1961.

Within the lower chaparral zone of Arizona, watershed management is concerned not only with water supplies, but also with maintenance of an adequate plant cover to control erosion.

The effect of recovery of vegetation, mechanical stabilization, and cover changes on storm runoff and sediment yields from nine small watersheds located on granitic soils in the lower chaparral zone are discussed.

Observations and measurements to date permit the following conclusions relative to the management of granitic watersheds in the lower chaparral zone:

1. Intense summer thunderstorms are characteristic of Arizona. Where the plant cover is sparse, and infiltration capacity low, surface runoff may be high. Surface flows carry considerable sediment, deepen channels, and generally increase erosion. To control erosion, management must be directed toward reduction of surface runoff.
2. Surface runoff and erosion were reduced, and a perennial grass cover was established by cutting woody vegetation and grubbing its roots, sloping steep gully sides, placing cut brush in gully channels, and then seeding to Boer and Lehmann lovegrasses.
3. Hardware-cloth checks placed on the contour also reduced erosion, but did not produce additional vegetation. Most surface runoff was produced during summer.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Chepil, W. S., Woodruff, N. P., and Siddoway, F. H. HOW TO CONTROL SOIL BLOWING. U.S. Dept. Agr., Farm B. 2169, 16 pp. 1961.

Soil erosion is caused by a strong wind blowing in the direction that gives the greatest distance across a large and unprotected field with a smooth and bare surface and a loose, dry, and finely granulated soil.

The following general ways can reduce or eliminate soil blowing: (1) Keep the soil firm and moist; (2) create soil aggregates or clods large and stable enough so they cannot be moved or abraded by wind; (3) roughen the surface to trap and protect the fine soil particles; (4) cover with and preferably maintain vegetation or residue on the land; (5) narrow the width of fields and arrange the broad sides of the fields at right angles to the prevailing direction of wind; and (6) reduce the velocity of wind near the ground by using barriers placed along the path of the wind.

Recommended methods to control soil blowing are: (1) Keep a crop or stubble on land as much as possible; (2) stripcrop on soils that permit strips; (3) plant row crops at right angles to prevailing winds; (4) maintain high soil productivity with fertilizers and rotations; (5) use tillage machines that provide a rough and cloddy surface; (6) plant a permanent cover of native vegetation on sands and extremely erodible soils; (7) use emergency tillage before blowing starts, if the methods above appear to have failed; and (8) work together in the community to control wind erosion.

ARS, USDA, Inform. Div., Washington 25, D.C.

Chepil, W. S. THE USE OF SPHERES TO MEASURE LIFT AND DRAG ON WIND-ERODED SOIL GRAINS. *Soil Sci. Soc. Amer. Proc.* 25: 343-345. 1961.

Experiments were conducted to determine the relative magnitude of lift and drag on small spheres, similar to soil grains, at different heights in a fluid boundary surface and to determine if these forces are related to movement of soil grains in saltation.

Lift on the average was about 75% that of drag when a sphere was at zero height. Lift decreased with height and virtually ceased a short distance above ground. The greater the ground roughness and drag velocity, and therefore the steeper the velocity gradient, the higher lift extended. It is concluded that lift is caused by a steep wind velocity gradient near the ground.

Drag on the spheres was generally much greater than lift. Drag increased directly with an increase in wind velocity and was apparently due to direct pressure of the wind against the sphere.

Lift alone is too small to cause the saltating grains to rise, as they do, essentially vertically. The predominantly vertical rise apparently is the way the saltating grains rebound from the ground.

SWCRD, ARS, USDA, Manhattan, Kans.

## Terraces

Jacobson, P. A FIELD METHOD FOR STAKING CUT AND FILL TERRACES. *Agr. Engin.* 42: 684-687. 1961.

Parallel terraces have for a long time been the goal of the conservation engineer. There are three methods that can be used to keep terraces parallel and avoid point rows. They are varying the grade of the terrace channel, using a turn strip on field ridges, and varying the depth of cut along the line in construction.

A field method of staking parallel terraces without the use of topographic or other types of maps is presented. A computed average grade line is used, which can be figured during layout, thus permitting needed adjustment as lines are laid in the field. During the last couple of years, several hundred miles of terraces have been laid out in Iowa with this method.

The author concludes that: (1) Cut-and-fill terraces provide an additional tool which, combined with grade variation and turn strips, will permit more terraces to be made parallel in a system; (2) on deep soils some land grading will further improve alignment, reduce point rows, and in some cases reduce the number of waterways required; (3) by computing the average grade line, someone experienced in staking terraces can compute cut and fills in the field without the use of a topographic map or plotting the profiles of the terrace; and (4) experience on construction indicates that the use of a bulldozer and a scraper in combination will materially reduce the cost of constructing cut-and-fill terraces.

SCS, USDA, Des Moines, Iowa.

### Critical Areas

Francis, C. J. HOW TO CONTROL A GULLY. U.S. Dept. Agr., Farm B. 2171, 14 pp. 1961.

Gullies occur in every section of the country. The extent of damage they cause depends on climate, topography, geology, soil type, and land use. Gullies that have developed over the ages through the process of natural or geologic erosion are a part of the general configuration of the landscape. Many gullies are created by accelerated erosion resulting from man's misuse of the land. These are the gullies that usually do the greatest damage; they are the kind of gullies that can and should be controlled.

Uncontrolled gullies on farmland and rangeland may advance to the point where they cut up fields or whole farms so they must be abandoned. Sediment from eroding gullies deposited on bottom land may destroy its value. Sediment trapped in reservoirs and deposited in stream channels creates large economic losses. Gullies may drain areas enough to reduce crop production. In some areas deep gullies may lower the ground-water table. Gully erosion and resultant sedimentation increase the cost of maintaining highways, railroads, pipelines, and other public utilities.

A system for disposing of water is necessary on all farms and ranches on which runoff occurs. It should provide for control of runoff and erosion so that gullies will not form.

The best way to control gullies is to prevent their formation. A good conservation plan put into effect before an extensive system of gullies has formed insures protection against gullies. It also may transform many gullies into good vegetated waterways and increase farm values.

The following methods of gully control are discussed and illustrated: (1) Natural revegetation; (2) planting trees or grass; (3) diversion of runoff; (4) ponds in gullies; (5) changing gullies to grass waterways; and (6) structural control.

SCS, USDA, Inform. Div., Washington 25, D.C.

Brown, R. C. CONCRETE CHUTE STOPS TEXAS GULLY. Land and Water Contract. 3(10): 14-15. 1961.

An illustrated article on the construction of a concrete chute made to stop a large gully on a farm near Muenster, Tex.

SCS, USDA, Gainesville, Tex.

Gullies and areas of severe sheet wash were studied. The plantings were on compact Coastal Plain soils except in several of the western counties where loess parent materials were exposed. Slopes ranged up to 30 percent.

In each of 12 counties, three blocks were planted to loblolly pine. Each block was composed of three treatment plots each 18 feet square. Nine 1-0 loblolly pine seedlings (3 rows of 3 seedlings) were planted within each plot at a 6- by 6-foot spacing--a total of 972 seedlings. Three treatments within each block were randomly assigned: (1) Post hole with mulch; (2) post hole without mulch; and (3) mattock planting without mulch (control treatment).

Six-inch holes were dug to a depth of 24 inches with a back-pack gasoline-powered post hole digger. The holes were refilled with the nearest approximation of topsoil that remained in the vicinity. On the mulched plots, loose hay or straw was placed to a 4-inch depth in a 12-inch radius around each seedling. The mattock holes were refilled with the original materials.

After 3 years, survival in post holes averaged 81 percent, despite general June-September rainfall deficiencies of up to 10 inches during the first growing season (table 1). In contrast, survival of all 1956 flood-prevention plantings in northern Mississippi averaged 58 percent after the first year. Seedlings in post holes also made superior height growth, especially those that had been mulched.

Table.--Average Survival and Height Growth of Loblolly Pine Under Various Planting Treatments After Three Growing Seasons

Treatments	Survival percent	Weighted height-growth feet
Post hole with mulch .....	86	2.7
Post hole without mulch .....	76	1.9
Mattock .....	66	1.4
Average .....	76	2.1

The power driven-augers kept planting costs within reasonable bounds. On moist sites, a two-man crew could dig 6-inch holes, 24 inches deep, at the rate of one per minute.

Regular spacing of planting holes is not recommended. Careful location of holes with regard to moisture and sediment characteristics can improve seedling performance. Digging and refilling holes in advance allow the soils to settle before the planting season. To aid re-location, holes can be marked with a stick or painted wire pin.

Spot mulching the post holes is recommended. The mulch probably improved moisture conditions, and it also held soil in place around the seedling and trapped additional sediment.

SWCRD, ARS, USDA, LaCrosse, Wisc.

Richardson, E. C., and Diseker, E. G. CONTROL OF ROADBANK EROSION IN THE SOUTHERN PIEDMONT. *Agron. J.* 53: 292-294. 1961.

Preliminary runoff and soil loss measurements made during the 2-year period, 1958-59, at bare, steep roadbank sites in the Piedmont of Northwest Georgia indicated that soil losses were excessive.

Highway roadbanks were effectively stabilized by seedings of adapted species. The most promising species include four grasses (tall fescue, common bermudagrass, Coastal bermuda-grass, and lovegrass), two legumes (crown vetch and *Lespedeza sericea*), and, for steep, rocky slopes, two vines (honeysuckle and Kudzu).

In this area, tall fescue is fall seeded, whereas the bermudagrasses and lovegrass are established in the spring. Crown vetch starts slowly from seed and a protective mulch is required during seedling establishment. The most promising way of providing this protection is to seed Abruzzi rye with the crown vetch. The fall-seeded rye becomes established rapidly and provides a straw mulch grown in place as protection for the seedlings of crown vetch. Crown vetch developed more rapidly when planted in September to March, inclusive. This combination was particularly promising in these studies.

Mulches were essential for holding seed and fertilizer in place on steep slopes. Mulch was essential to insulate and protect slowly developing species on all slope conditions. Mulch was not so essential for rapidly developing grasses on moderate slopes. Crop straw mulches or mulch grown in place with Abruzzi rye were superior to other mulches tested.

SWCRD, ARS, USDA, Cartersville, Ga.

## SOIL MANAGEMENT

### Cropping Practices

Laws, W. D. FARMING SYSTEMS FOR SOIL IMPROVEMENT IN THE BLACKLANDS.  
Hoblitzelle Agr. Lab., B. 10, 27 pp. 1961.

The restoration of productivity to the Blackland soils by means of farming systems has been under investigation the past 12 years. Seventeen different farming systems were established and soil samples from ten of the systems were studied extensively to determine the effects on various soil properties.

Only systems with an annual average return of more than 3,600 pounds of residue per acre maintained the organic matter content of the soil at a constant level. A larger quantity was required to increase the original organic matter content a significant amount. On the average, a significant increase in organic matter did not occur on systems producing less than 5,100 pounds of aboveground residue per acre annually.

All the systems with wheat in the cropping sequence returned an average of more than 3,600 pounds of aboveground residue per acre to the land annually. The systems without wheat in the cropping sequence failed to produce this amount.

Although the fertilized grain sorghum produced more than 3,600 pounds of aboveground residue per acre annually, the unfertilized grain sorghum, Hubam clover and cotton averaged much less than this amount. For production of 3,600 pounds of aboveground residues by cotton, seed cotton yields of from 1,000 to 1,100 pounds per acre are necessary.

The water stable aggregates increased only in the systems of continuous wheat. In the rotations the degree of aggregation remained about constant over 12-crop years but declined in all one crop systems except as noted above.

Eighteen pounds of nitrogen per acre annually resulted in a measurable increase of soil nitrogen in the system of continuous wheat fertilized, but an application of 32 pounds of nitrogen per acre annually failed to maintain the nitrogen level of the soil when cropped continuously to cotton. In contrast to the systems of continuous grain sorghum and continuous cotton

not fertilized--both of which showed a significant decrease in soil nitrogen--the system of continuous wheat not fertilized showed no measurable change in soil nitrogen during the 12-crop period.

The system of wheat-cotton-grain sorghum not fertilized lost less nitrogen during 12-crop years than either continuous cotton or continuous grain sorghum not fertilized. Under continuous cotton not fertilized the nitrogen loss was nearly three times the loss under the rotation, while the loss under continuous grain sorghum was over three and one-half times that for the three crop system. These results indicate that farming systems where crops are rotated and all residues are returned to the land are valuable in maintaining the productivity of the soil.

The use of phosphate fertilizers in the farming systems is essential to the maintenance of soil productivity. The total and available phosphorus content of the soil declined in the systems not receiving phosphate fertilization.

The systems with wheat in the cropping sequence proved more satisfactory than those with either Hubam sweet clover or perennial grass sod. There are two reasons for this:

(1) The income from wheat was usually higher than for either the clover or the perennial sod; and (2) it returned much larger quantities of aboveground residue to the soil than either the Hubam sweet clover or the sod cut for hay, and thus was a better "soil improving" crop.

In order to maintain soil productivity it is essential that all crop residues produced in a farming system be returned to the soil. The residues should never be burned or otherwise removed from the land.

Hoblitzelle Agr. Lab., Tex. Res. Found., Renner, Tex.

Lawson, W. W., Brough, O. L., Jr., Swanson, J. P., and Horner, G. M. ECONOMICS OF CROPPING SYSTEMS AND SOIL CONSERVATION IN THE PALOUSE. Coop. Study of the Agr. Expt. Sta. of Idaho, Oregon, and Washington and the ERS and SWCRD, ARS, USDA. B. 2, 82 pp. plus appendix. 1961.

The income obtainable from alternative cropping systems on a typical farm in the Palouse wheat-pea area is reported. It shows the effects of various cropping systems on soil productivity. It answers the question "what are the most profitable cropping systems that farmers can use without significantly impairing the productivity of their land?"

The findings indicate that farmers can adopt cropping systems that will maintain the productivity of the soil better than the prevailing wheat-pea system and that will produce as high or higher net income under the price and cost conditions considered.

A number of crop rotations adapted to this area were selected for study. These cropping systems vary in the degree to which they will conserve or deplete productivity of the soil. The effects of each cropping system on soil erosion, soil organic matter, crop yields, and farm income have been evaluated with and without the use of commercial fertilizer. These cropping systems have been appraised both with and without regard to current wheat acreage allotments.

Wheat is the most important crop in all cropping systems, either with or without wheat acreage allotments, and at varied prices for commodities. Price supports affect farm income. But with or without them, farmers in the Palouse can adopt cropping systems that will conserve soil resources to a high degree with little or no sacrifice in income.

Table 2.—Crop Rotations and nitrogen Fertilizer use in Relation to Wheat Acreage, Soil Erosion Losses, Soil Organic Matter Trends, Wheat Yield, and Net Income on a Typical Farm in the Palouse Wheat-Tea Area

Crop Rotation <sup>a</sup>	Percentage of Cropland in Wheat <sup>b</sup>	Average Annual Soil Losses per Acre (Tons) <sup>c</sup>	Percentage Change in Soil Organic Matter per Year <sup>d</sup>	Average Yield of Wheat per Acre (Bushels)		Net Income per Farm <sup>e</sup>
				Without nitrogen fertilizer	With nitrogen fertilizer	
Rotations Without Green Manure or Hay Crops						
Wheat-tallow rotation.....	50.0	6.2	-0.65	-0.40	44.0	53.5
Wheat-pea rotation.....	50.0	5.6	-0.50	-0.10	36.0	50.7
Recropped wheat rotation.....	85.7	4.7	-0.51	+0.04	25.2	48.2
Rotations With 2-year Old Alfalfa Green Manure						
5-year rotation with wheat and peas.....	40.0	5.0	-0.01	+0.07	45.7	52.4
5-year rotation with recropped wheat.....	50.0	4.5	+0.01	+0.13	38.4	50.8
3-year rotation.....	33.3	4.5	+0.26	+0.28	48.0	51.5
Rotations With Alfalfa Hay						
12-year rotation with wheat and peas.....	41.6	3.9	-0.20	+0.07	40.4	49.4
12-year rotation with recropped wheat.....	66.6	3.4	-0.22	+0.14	32.1	47.9
8-year rotation with wheat and peas.....	37.5	3.3	-0.06	+0.13	41.8	48.8
8-year rotation with recropped wheat.....	56.2	2.9	-0.08	+0.18	34.6	47.7
						Net Income per Farm <sup>e</sup>
						With no nitrogen fertilizer
						With no wheat acreage restrictions
						With wheat acreage allotments

<sup>a</sup> Specific crop sequences are shown in Table 5.

<sup>b</sup> Refers to percentage of cropland in wheat with no wheat acreage allotments. With wheat acreage allotments, 32 percent of the land is in wheat in all rotations.

<sup>c</sup> Data apply to situations without wheat acreage allotments. They differ just slightly with acreage allotments.

<sup>d</sup> Refers to the annual rate of change expressed as a percentage of the present level of soil organic matter.

<sup>e</sup> Refers to net income to capital and management on a typical wheat farm containing 520 acres of cropland. These figures are based on the following prices: wheat, \$.60 per bushel; peas, \$3.50 per cwt.; barley, \$4.24 per ton; and alfalfa hay, \$15 per ton.

Tables, charts, maps, and graphs.

Wash. Agr. Expt. Sta., Pullman, Wash.

Porter, J. A., and Lucas, R. E. 50 BUSHELS OF CORN PER HOUR... BY A MAN WITH A TRAIN! Better Crops with Plant Food. 45(6): 24-26. 1961.

Richard S. Walters of Leelanee County, Mich. obtained a yield of 148 bushels per acre from a measured 5 acres.

He realized 50 bushels of corn per manhour of labor by combining high population, adequate fertilization, and weed control with his own version of plow-plant.

The plow-plant combination might be described as a corn planting "train" as it has an overall length of 31 feet, with the couplings linking five components into a smoothly running, efficient outfit.

The field with mulch from last year's cornstalks is plowed, fertilized, planted, and weed-protected at the rate of 2 acres per hour. The next operation is corn picking. Besides the planting and harvesting, the only other field operation is shredding the stalks.

Much of the land on which Mr. Walters plants his corn, normally about 400 acres, has a rather heavy soil, Hoytville cl to sicc. With plow-plant and no cultivation, the soil is improving in structure from year to year.

Moisture from rains and melting snow more quickly replenishes soil supplies and excess moisture more quickly reaches the tile drains. This is allowing earlier planting than when traditional tillage methods were used.

There are also areas of lighter textured soils (Berrien lfs). The "train" operates with equal effectiveness on this soil also.

Mich. State U., East Lansing, Mich.

Winchester, J. A., and Hayslip, N. C. THE EFFECT OF LAND MANAGEMENT PRACTICES ON THE ROOT KNOT NEMATODE, (MELOIDOGYNE INCognITA ACRITA), IN SOUTH FLORIDA. Fla. State Hort. Soc. Proc. 73: 100-104. 1960.

Established populations of M. incognita acrita in small plot experiments were very rapidly reduced when pure stands of pangolagrass were maintained in the plots. Coastal Bermudagrass was also effective in holding the nematode populations at a low level. While no nematodes were found in the soil 2 months after the establishment of pangolagrass, it is apparent that in commercial practice, where pure stands are difficult to obtain, this interval may be much longer. It has been demonstrated in other studies that a pure stand of pangolagrass may be hastened by: (1) Planting in the spring; (2) using a large amount of planting material; (3) supplying adequate moisture; and (4) fertilizing heavily with high nitrogen formulations. The large field plot experiment indicated that root-knot nematode problem can be controlled by pangolagrass. It should be emphasized that the results of these experiments would not be expected following a mixture of pangolagrass and other weed and grass species.

The results suggest that certain grass species, thought by many to be non-hosts to root-knot nematodes, may actually build up or hold that population at a high level. Crabgrass, Common Bermudagrass, and water sedges are widespread on most "old" farm lands. These grasses appear to be excellent hosts for M. incognita acrita even though a casual examination of their root systems probably would show no galling.

Clean fallow and clean fallow plus flooding were about equal in their effectiveness in controlling the nematodes, and neither method was superior to pangolagrass. Although clean fallow appears to be effective for root-knot nematode reduction, this cultural practice creates other production problems. The loose sand is easily eroded and blown during heavy rains and winds. This results in a "water-logged" root system and sand damaged plants where clean fallow is practiced. Pangolagrass should be a more effective and economical method of

nematode control because: (1) The grass may be utilized for planting material, hay, silage, or grazing; and (2) the stubble and root system of pangolagrass is highly effective in eliminating bed erosion by wind and water.

Experiments to be reported at a future date indicate that the mature roots of pangolagrass contain a chemical which is toxic to M. incognita acrita. Other studies in progress are designed to determine the effect of pangolagrass on other major parasitic nematodes.

Fla. Agr. Expt. Sta., Indian River Field Lab., Fort Pierce, Fla.

### Crop Residue Management

Mannering, J. V., and Meyer, L. D. THE EFFECTS OF DIFFERENT METHODS OF CORNSTALK RESIDUE MANAGEMENT ON RUNOFF AND EROSION AS EVALUATED BY SIMULATED RAINFALL. *Soil Sci. Soc. Amer. Proc.* 25: 506-510. 1961.

The effects of three methods of cornstalk residue management on runoff and erosion were studied in the field on a Warsaw 1 of 4 to 4-1/2% slope and a Russell sil of 3 to 3-1/2% slope. These methods were: (1) Cornstalks as left by a cornpicker (check); (2) cornstalks shredded after corn was picked; and (3) cornstalks shredded and disked once. Simulated rainstorms at a constant intensity of 2.4 inches per hour were applied on each of two successive days by the rainulator, a field-plot rainfall simulator. Infiltration, runoff, soil content of the runoff, and total soil loss were determined for both locations. Soil losses from the shredded treatment were <1/2 the losses from the check treatment for both soil types. Since runoff from the two treatments were nearly identical, the reduction in soil loss was due to the lower soil content of the runoff. Soil losses from the shredded-plus-disked treatment were between those of the check and shredded treatments. Conclusions were, that, (1) Shredding cornstalks in the fall can reduce soil losses significantly during the winter months and (2) disk shredding cornstalks is undesirable from a soil conservation standpoint.

SWCRD, ARS, USDA, Lafayette, Ind.

Army, T. J., Wiese, A. F., and Hanks, R. J. EFFECT OF TILLAGE AND CHEMICAL WEED CONTROL PRACTICES ON SOIL MOISTURE LOSSES DURING THE FALLOW PERIOD. *Soil Sci. Soc. Amer. Proc.* 25: 410-413. 1961.

Maintaining surface residues with stubble-mulch tillage or chemical weed control significantly improved moisture conditions in the seed zone and markedly reduced surface crusting. Field and laboratory studies showed the drying rate of the 0- to 1/2-inch portion of the soil profile was greatly reduced by plant residues on the soil surface. However, under field conditions soil moisture content below 2 inches was not materially increased by surface residues. The value of surface residues to increase moisture storage during the fallow period is discussed.

SWCRD, ARS, USDA, Fort Collins, Colo.

Bond, J. J., Van Doren, C. E., and Army, T. J. FALLOWING FOR WHEAT PRODUCTION. *J. Soil and Water Conserv.* 16: 163-165. 1961.

Three methods of fallow for winter wheat production on medium- to fine-textured soils of the Southern Great Plains were evaluated in relation to moisture storage, soil organic matter, grain yields, and erosion control.

One-way fallow is the least effective method of controlling wind erosion. With the one-way, a portion of the crop residue is covered with each and the soil is pulverized and void of a protective cover.

Fourteen years of crop data showed that yields on early and delayed stubble-mulch fallow were similar. Yields with one-way disc plowing, early fallow, averaged about 2 bushels less than yields with either of the stubble-mulching systems. Delayed stubble-mulch fallow usually contained somewhat more soil moisture at seeding than did the two methods of early fallow. Delayed stubble-mulch fallow reduced losses of organic matter and nitrogen and improved wind erosion protection.

Stubble-mulch tillage leaves a maximum amount of residue on the surface; but unfortunately, a portion of the residue is lost with each tillage operation. The residue is also left in a decumbent position that limits its effectiveness in reducing wind velocities near the surface. Delayed fallow gives a maximum of wind erosion protection during the critical late winter and spring blowing season in that the wheat stubble and first summer weed and volunteer wheat growth is left standing. With delayed fallow there is always a maximum amount of residue on the soil surface.

All results indicate that the incorporation delayed fallow should be considered in dry-land wheat-fallow systems on the medium-to fine-textured soils of the Southern Great Plains.

SWCRD, ARS, USDA, Newell, S. Dak.

## Tillage

Hobbs, J. A., Herring, R. B., Peaslee, D. E., Harris, W. W., and Fairbanks, G. E. DEEP TILLAGE EFFECTS ON SOILS AND CROPS. *Agron. J.* 53: 313-316. 1961.

The effect of deep tillage, at 6 to 24 inches, with chisel-type implements on soils with definite restricting layers were studied in Kansas from 1952 to 1957. The soils ranged from very fine sandy loams to silty clay loams. At a few locations, the restricting layers resulted from tillage; while at other locations, they were caused by soil development processes.

In eastern Kansas, the results of deep placement of fertilizer materials were compared with those from surface application.

Tillage effects were measured in terms of soil bulk density, soil permeability, infiltration rate, moisture storage during fallow, and by crop response.

The following conclusions were drawn from the experimental results:

1. Deep tillage improved the physical condition of impermeable subsurface layers in some dryland soils.
2. This improvement in subsurface condition was not accompanied by increased rate of water entry or water storage after subsequent tillage erased the subsoiler or chisel marks.
3. The improved subsurface physical condition increased neither crop nor crop yields under dryland farming conditions.
4. In more humid regions, small crop yield increases were occasionally obtained when soils with restricting claypan layers were subsoiled. These increases were obtained only in years when climatic and other conditions favored high yields and increases were insufficient to cause increased profit.
5. Deep placement of fertilizer (14 to 16 inches deep) rarely increased crop growth over that obtained by surface applications of the same quantities of fertilizers. When increased yields were obtained, the increases were not large enough to pay for the placement operation.

Kans. Agr. Expt. Sta., Manhattan, Kans.

Minimum tillage and the use of mulches will greatly reduce soil and water losses from cultivated strips and the intervals between terraces. On corn after hay, wheel track planting and preparing the seedbed with a field cultivator each reduced runoff by about 50 percent and soil loss by about 75 percent. Corn stover mulch in corn after corn gave excellent control of runoff and erosion at La Crosse on a 16 percent slope and at Madison on a 9 percent slope. For a 6-year period at La Crosse, runoff averaged 0.11 inch and soil loss 0.16 tons per acre and at Madison for a 5-year period runoff averaged 0.06 inch and soil loss 0.01 ton per acre.

Soil losses from land in small grain can be reduced about 50 percent by use of a field cultivator for seedbed preparation in place of plowing. Chopping the corn stover as a mulch on the soil surface and preparing the seedbed with a field cultivator will reduce soil losses by about 80 percent as compared to seedbed preparation by plowing.

Interseeding legumes in wide row corn will successfully establish stands of hay which produce yields comparable to seeding made in small grain. The rotation, corn-hay-hay, will allow about one-fourth as much soil loss as a corn-small grain-hay rotation, largely because the small grain crop with its high soil loss is replaced by a year of hay with low soil loss.

SWCRD, ARS, USDA, La Crosse, Wisc.

### Fertility Requirements for Conservation Farming

Eck, H. V., and Fanning, C. PLACEMENT OF FERTILIZER IN RELATION TO SOIL MOISTURE SUPPLY. *Agron. J.* 53: 335-338. 1961.

Depth of placement of fertilizer was studied under two moisture regimes. In one, the soil zone which contained the fertilizer was wetted initially and not rewetted, while in the other that zone was not allowed to dry out. RS-610 hybrid grain sorghum was the test crop.

On the dry series, phosphorus uptake ceased when the soil reached the vicinity of the wilting point, but, nitrogen absorption apparently continued. Nitrogen absorption increased with depth of placement on that series.

On the wet series, phosphorus uptake increased with depth of placement, thus with increasing soil moisture content. Nitrogen uptake was not affected by depth of placement on this series. Phosphorus fertilizer should be placed deep enough to insure its being in moist soil longer than the initial growth period if it is to be effective. Placement of nitrogen fertilizer is less critical.

SWCRD, ARS, USDA, Bushland, Tex.

Hunter, A. S., Alban, L. A., Gerard, C. J., Hall, W. E., Cushman, H. E., and Petersen, R. G. FERTILIZER NEEDS OF WHEAT IN THE COLUMBIA BASIN DRYLAND AREA OF OREGON. *Oreg. Agr. Expt. Sta. Tech. B.* 57, 60 pp. 1961.

During the 4-year period 1953-57 fertilizer experiments were completed on 173 dryland wheat farms in Umatilla, Morrow, Gilliam, Sherman, and Wasco Counties in north central Oregon. Of 173 experimental sites, 152 were in areas of low rainfall (below 15") and 21 in areas of higher rainfall (above 15").

Significant yield increases were produced by one or more rates of fall- and spring-applied nitrogen, respectively, on 109 and 112 of 152 sites in the low rainfall area. For 109 sites, average yield increases from 20, 40, 60, 80, and 100 pounds of nitrogen per acre, were respectively 6.4, 10.2, 12.2, 12.2, and 12.2 bushels per acre. Average yield increases from spring-applied nitrogen at rates of 20, 40, 60, 80, and 100 pounds, respectively, were 4.9, 8.8, 11.2, 11.9, and 12.8 bushels per acre. Effects of fall- and spring-applied nitrogen fertilizer were too small to be significant on 15.8 and 19.1%, respectively, of the sites in low rainfall areas. Significant yield decreases were produced by one or more rates of fall-applied nitrogen on 12.5% and by spring-applied nitrogen on 7.2% of low rainfall area sites. Considering all sites in the low rainfall area, average yield increases from 20, 40, and 60 pounds of fall-applied nitrogen were 4.8, 7.3, and 8.3 bushels per acre, respectively; higher rates produced lower average yields. For 20, 40, 60, 80, and 100 pounds of spring-applied nitrogen average yield increases were, respectively, 3.9, 6.5, 8.3, and 8.7 bushels per acre.

During the 4-year period for all sites, fall-applied nitrogen was superior to spring-applied nitrogen on 38, inferior on 42, and not significantly different on 91 sites. Fall-applied nitrogen resulted in larger average yield increases and also a greater number of yield depressions than spring-applied nitrogen. Yield depressions from fall-applied nitrogen were usually associated with soil depths of less than 4 feet.

The amount of nitrogen required to increase wheat yield by 1 bushel per acre varied with year, experimental site, and soil type. It ranged, over the 4 years, from 2.8 to 6.3 for fall-applied and 3.2 to 6.0 pounds for spring-applied nitrogen. For 109 sites an average of 3.7 pounds of fall-applied nitrogen was required to increase wheat yields by 1 bushel per acre. Spring-applied nitrogen was less efficient in increasing yields, requiring an average of 4.3 pounds of nitrogen per bushel increase.

Residual effects of spring-applied were greater than those of fall-applied nitrogen. Substantial residual effects of both fall- and spring-applied nitrogen were measured on 10 sites following a year of fallow.

Protein contents of wheat in this area may be a useful index to adequacy of fertilizer nitrogen usage on an individual field. In these experiments, protein contents were not, in general, increased to objectionably high levels except by rates of nitrogen greater than the rate required to produce maximum yield. Substantial yield increases were usually obtained from added nitrogen on fields where the grain from the no-nitrogen plots contained less than 8% protein. Protein contents of 9% or more indicated adequate supplies of nitrogen relative to other factors limiting yields.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

Brown, A. R., Morris, H. D., and Morey, D. D. RESPONSE OF SEVEN OAT VARIETIES TO DIFFERENT LEVELS OF FERTILIZATION. *Agron. J.* 53: 366-369. 1961.

Seven winter oat varieties were grown on Cecil s1 of low fertility and were subjected to 3 rates of fertilization for a 3-year period. The rates of fertilization were: Low--no fertilizer at planting plus 16 pounds' N per acre topdressing; medium--300 pounds' 6-8-6 at planting plus 32 pounds' N topdressing; high--600 pounds' 6-8-6 at planting plus 64 pounds' N topdressing. The following results were obtained: (1) Significant differences in yield occurred among varieties and among fertilization rates. Although a significant variety fertility level interaction was obtained the highest yielding varieties were superior at the medium and high fertility levels. This fact indicates that oat variety tests should be conducted on well-fertilized soil and recommendations made without regard to soil fertility level. (2) Protein content of the grain and straw weight of all varieties increased significantly as fertility level increased. Greatest increase in protein content occurred when the fertility

level was increased from medium to high. (3) Medium and high fertilization hastened the average heading date by 2 days as compared to low fertilization, but high fertilization caused a decrease in contrast to low fertilization. (4) Applying high rates of fertilizer to a low-yielding variety resulted in a loss of income. Applying medium and high rates to high-yielding varieties produced the highest income. And (5) yield increases resulting from the higher rates of fertilization were a function of increased tillering and panicle length.

Ga. Agr. Expt. Sta., U. Ga. Agr., Athens, Ga.

Locascio, S. J., and Thompson, B. D. STRAWBERRY YIELD AND THE SOIL NUTRIENT LEVELS AS AFFECTED BY FERTILIZER RATE, TYPE OF MULCH AND TIME OF APPLICATION. Fla. State Hort. Soc. Proc. 73: 172-179. 1960.

An experiment was designed to study the effect of fertilizer level, type of mulch, and time of application of both on the soil nutrient level and on the yield of strawberries. The data presented indicate the following:

1. The early and total yields of strawberries were significantly greater from plastic-mulched plots than from paper, pine straw, or non-mulched plots.
2. Plastic mulch applied at planting time with all of the fertilizer was superior to that applied 1 month later with a split fertilizer application.
3. Paper, pine straw, and no mulched plots yielded more fruit when mulched 1 month after planting and received a split fertilizer application.
4. Yield increased linearly up to the rate of 2,000 pounds per acre of 6-8-6 fertilizer.
5. No interaction of the yield of cull fruit and treatment was found. Treatments responsible for highest marketable yields also produced highest yield of cull fruit.
6. The average soil potassium level was higher under plastic mulch than under pine mulch. The level tended to be higher under plastic than under paper or non-mulched plots. The soil K<sub>2</sub>O level increased cubically with increased fertilizer.
7. The soil phosphorus level increased linearly with increased fertilizer rates. Mulch or time of application had no effect.
8. The moisture level of the soil was higher under plastic and pine straw mulch than under paper or non-mulched plots.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Hileman, L. H., Beacher, R. L., and Thompson, L. F. FERTILIZATION AND SOIL TEST STUDIES ON COMMON AND COASTAL BERMUDAGRASS. Ark. Agr. Expt. Sta. B. 637, 40 pp. 1961.

COMMON BERMUDAGRASS--yield and chemical soil test data were obtained from two outlying fertilizer experiments for a 5-year period. Sods were old established sods in Marion County and in Union County in Arkansas. These experiments were designed to measure yield response from nitrogen applications with more precision than response from phosphate and/or potash.

The greatest total yield each year was produced by the highest rate of nitrogen applied. During the first 3 years this rate was the 167-pound nitrogen rate, and during the last 2 years it was the 234-pound nitrogen rate. The lowest rate of nitrogen (33 pounds) significantly increased yields in 2 out of 3 years at the Union County location and in all 3 years at the Marion County location.

Where additional growth is needed for hay purposes, it appears that yield at the first cutting can be increased by as much as 100 percent by the application of at least 67 pounds of nitrogen in early spring.

There was no advantage from making split applications of the high nitrogen rates. In years of below normal rainfall, some advantage was gained from splitting the moderate nitrogen rate (100 pounds N).

Urea as a source of nitrogen was equal to ammonium nitrate in 4 out of 5 years at Marion County and in 2 out of 5 years at Union County.

Phosphate alone increased yields in 3 out of 5 years in Union County. When potash was applied with phosphate, yield was increased in all 5 above no-treatment and above phosphate-alone in 4 out of 5 years. There was no difference in yield between the phosphate-alone and the phosphate-with-potash treatments at the Marion County location.

Soil pH was not affected by the application of phosphate and potash. All but the lowest nitrogen treatment (33 pounds N) significantly decreased the soil pH. Split-nitrogen applications reduced the soil pH to a greater degree than did single applications of the same rate. A 2-ton per acre lime topdressing corrected the soil pH in the 0- to 2-inch soil layer but had little effect below this depth.

The application of phosphate, alone or with potash, was effective in increasing the soil phosphate level at the Marion County location at all levels of applied nitrogen but had little effect at the Union County location. Buildup of the soil phosphate level occurred at both locations where no nitrogen or the low rate of nitrogen was applied.

The addition of potassium increased the soil test level of this element at Marion County where no nitrogen or the low rate of nitrogen was applied. At Union County there was no increase in the soil potassium level at any level of nitrogen application. Significant decreases in the soil potassium level occurred at both locations where nitrogen was applied at rates of 100 or more pounds per acre actual nitrogen.

Applying 2 tons of agricultural limestone per acre as a topdressing increased the calcium level in the top 2 inches of soil at both locations.

Nitrogen applications exceeding 100 pounds per acre actual nitrogen significantly reduced the soil magnesium level in the top 6 inches of soil. At depths greater than 6 inches, magnesium tended to increase. Lime applications had no apparent effect on the soil magnesium content.

COASTAL BERMUDAGRASS--greatest total yield was produced each year by the 234-pound nitrogen treatment applied in three applications to a Coastal bermudagrass sod in Columbia County.

The split-method of applying nitrogen was superior to one early spring application in increasing total yield. It was also more efficient in terms of pounds of forage produced per pound of nitrogen applied, regardless of rainfall.

Coastal bermudagrass can utilize large quantities of nitrogen. More than 7-1/2 tons per acre of dry forage was produced by the 234-pound per acre nitrogen application. Very low yields and poor growth resulted where no nitrogen or low rates were applied.

The applications of phosphate and of phosphate with potash had no effect on forage yield on this soil. A profile soil test showed that an adequate supply of these elements was available in the subsoil. Phosphate was concentrated in the top 6 inches of the soil. Potassium was concentrated below the 14-inch soil depth. The soil magnesium level increased from 30 parts per million in the 0- to 12-inch soil region to 480 parts per million in the 14- to 24-inch region.

Agr. Expt. Sta., U. Ariz. Fayetteville, Ark.

Adams, J. R., Anderson, M. S., and Hulbert, W. C. LIQUID NITROGEN FERTILIZERS: FOR DIRECT APPLICATION. U.S. Dept. Agr. Agr. Hbk. 198, 44 pp. 1961.

The direct application of liquid materials as fertilizer carrying nitrogen as the only primary nutrient element has greatly increased in the United States since World War II.

Such use of these liquids--comprising mostly anhydrous ammonia, aqua ammonia, and aqueous solutions of ammonium nitrate and (or) urea with or without ammonia--accounted for about 46 percent of the consumption of nitrogen in direct-application materials in the year ended June 30, 1958, as compared with only 8 percent in 1946-47. Liquids are also the principal form in which nitrogen is supplied to domestic manufacturers of mixed fertilizers.

Liquid nitrogen fertilizers have certain advantages over conventional solid fertilizers. Many of the liquids have a higher nitrogen content and cost less per pound of nitrogen. They can be applied accurately to the soil without dusting and are more adaptable to incorporation in the water of irrigation systems. Ease of handling is a major consideration. Liquid fertilizers are handled mechanically so that the lifting and carrying of heavy bags of fertilizer are eliminated. Liquid nitrogen fertilizers, however, are corrosive and require special application equipment and storage containers. Many of them must be handled in pressure equipment. A drop in temperature may cause salting out of some of the dissolved solids and subsequent clogging of equipment.

This publication brings together information on the consumption, composition, and properties of liquid nitrogen materials; the process and facilities for their manufacture; the methods, equipment, and safety precautions for their storage, transportation, and application; and the agronomic and economic considerations in their use.

ARS, USDA, Inform. Div., Washington 25, D.C.

Purvis, E. R. UREA IS SATISFACTORY NITROGEN SOURCE UNDER MOST CONDITIONS. N.J. Agr. 43(2): 5-7. 1961.

Nixon sl and Lakewood s were selected to study the loss of ammonia from applied urea. The following conclusions were made from the study: (1) Losses of ammonia through volatilization from surface-applied urea, at rates to supply 50 pounds of nitrogen per acre or less, are negligible under New Jersey conditions when soil pH is below 6.5 and soil temperatures do not exceed 72° F. Rates of application up to 100 pounds of nitrogen per acre are probably economical on all but the sandier types of soils. (2) At the rates normally applied, urea is equally effective as ammonium nitrate as a nitrogen source for topdressing winter grains. And (3) The greatest losses of ammonia occur when urea is applied to heavy grass sods when soil temperatures are above 70° F. Under these conditions, other nitrogen sources should be used.

Rutgers-the State U. N. J.-New Brunswick, N. J.

Everett, P. H. THE INFLUENCE OF NITROGEN SOURCE AND FERTILIZER RATE ON WATERMELON YIELDS. Fla. State Hort. Soc. Proc. 73: 107-111. 1960.

Fertilizer experiments with watermelons (var. Charleston Gray) were conducted on virgin Immokalee fs during 1958, 1959, and 1960. The effects on yield of different nitrogen sources and fertilizer rates were measured.

The use of a complete fertilizer with 30% of the nitrogen derived from natural organics resulted in significantly higher yields when compared to the yields from three all-inorganic nitrogen sources. Of the three inorganic nitrogen sources tested, highest yields were associated with ammonium sulfate and lowest yields with sodium nitrate. Yields obtained from ammonium nitrate were intermediate between the yields from ammonium sulfate and sodium nitrate.

Higher yields of early melons were also associated with the organic nitrogen source. Ammoniacal ( $\text{NH}_4$ ) and nitrate ( $\text{NO}_3$ ) nitrogen determinations on soil samples indicate that higher yields resulted when the  $\text{NH}_4\text{-NO}_3$  ratio was relatively high.

The effect on yield of different fertilizer rates was less pronounced or consistent than the effect of nitrogen source. In 1958 and 1960, there were significant differences in yields with respect to fertilizer rate, but in 1959 the yield differences among the three rates tested were not significant.

Determinations of total soluble salts in the soil solution indicated that in irrigated areas a high salt content is not detrimental to the growth of watermelons.

Fla. Agr. Expt. Sta., South Fla. Field Lab., Immokalee, Fla.

Heilman, M. D., Thomas, J. R., and Burleson, C. A. NITROGEN REQUIREMENTS OF CABBAGE. J. Rio Grande Hort. Soc. 15: 106-111. 1961.

The yields of marketable cabbage and total plant material increased with successive 60-pound increments of nitrogen through 180 pounds per acre. Yields were directly related to the nitrogen content of the plant material. Nitrogen fertilization also increased the percentage of total plant material that was marketable.

Nitrogen recovery was 90, 57, and 75 percent from 60, 120, and 180 pounds of nitrogen, respectively.

Nitrogen response by cabbage on different soil types is apparently related to the nitrogen content of the soil as reflected by the total nitrogen percentage. This is particularly true with the loam soils.

SWCRD, ARS, USDA, Weslaco, Tex.

Pearson, R. W., Jordan, H. V., Bennett, O. L., Scarsbrook, C. E., Adams, W. E., and White, A. W. RESIDUAL EFFECTS OF FALL- AND SPRING- APPLIED NITROGEN FERTILIZERS ON CROP YIELDS IN THE SOUTHEASTERN UNITED STATES. U.S. Dept. Agr., Tech. B. 1254, 19 pp. 1961.

Nitrogen fertilizer broadcast in November or December on widely different soils at seven locations in Alabama, Georgia, and Mississippi during 1955-59 was only 49 percent as effective as nitrogen fertilizer applied the following spring when measured by corn yields. In terms of nitrogen recovered, the relative effectiveness was 62 percent.

There were no consistent differences among the five nitrogen sources, (ammonium nitrate, sodium nitrate, urea, ammonium sulphate, and anhydrous ammonia) applied in the fall as measured by corn yields, but nitrogen recovery tended to be lower from urea than from the other sources.

There were marked variations in the effectiveness of fall-applied nitrogen at different locations. These variations could not be explained on the basis of rainfall, estimated percolation, or soil texture. Thus, leaching does not appear to be the primary reason for the low relative effectiveness of fall-applied nitrogen.

Appreciable losses of nitrogen occurred in runoff from a fine-textured soil between application of nitrogen in the fall and planting of corn the next spring. Such losses from a sandy loam were negligible.

Recovery of spring-applied nitrogen by the fertilized crop decreased with increasing rate, amounting to little more than 50 percent at recommended rates of application. The economic implications of this low effectiveness emphasize the necessity for developing management practices to improve utilization of applied nitrogen by the fertilized crop.

Considerable residual effects of spring-applied nitrogen were found over a period of 16 months based on both yield and nitrogen uptake by the crops. Average uptakes of 25 and 34

pounds per acre of additional nitrogen were made by the second and third crops, respectively, from the 200-pound original application. This residual nitrogen produced average yield increases of 1,600 pounds of dry forage and 19 bushels of corn per acre. These results emphasize the economic importance of residual nitrogen and the need for soil test procedures for its estimation.

ARS, USDA, Inform. Div., Washington 25, D.C.

Adams, W. E., Pearson, R. W., and Morris, H. D. RESIDUAL EFFECTS OF FALL AND SPRING NITROGEN APPLICATIONS IN THE GEORGIA PIEDMONT. *Ga. Agr. Res.* 2(3): 7-8. 1961.

Nitrogen applied in the fall of the year on Cecil s1 was much less effective for corn production than spring-applied nitrogen. Surface broadcast urea was inferior to anhydrous ammonia, ammonium sulfate, ammonium nitrate, and sodium nitrate as a source of fall-applied nitrogen. A 30-pound per acre rate of nitrogen applied in the fall was 60 percent as effective as spring-applied nitrogen and a 90-pound rate applied in the fall was only 49 percent as efficient as spring applied.

Residual effects from fall- and spring-applied nitrogen were measured by yields of oat and corn crops following the fertilized corn crop. When nitrogen was applied at a rate of 90 pounds per acre or higher, marked increases in yields of oat forage and corn grain were obtained as a result of the residual nitrogen.

SWCRD, ARS, USDA, and U. Ga., Ga. Agr. Expt. Sta., Athens, Ga.

Grant, E. A., and Brown, C. S. YIELD AND NITROGEN UPTAKE OF FORAGE SEEDINGS AS AFFECTED BY NITROGEN FERTILIZATION. *Canad. J. Plant Sci.* 41: 176-187. 1961.

Over 2 tons of dry matter per acre were obtained from seedings of timothy and brome in the seeding year with an application of 100 pounds of nitrogen per acre. Nitrogen at 200 and 400 pounds per acre produced no further significant yield increase. In the second year, yields were significantly increased by each increment of nitrogen applied in the seeding year up to and including 400 pounds per acre with brome and 200 pounds per acre with timothy. Nitrogen content of grasses increased with each increment of nitrogen in the seeding year but this effect was not consistent in the second year. Over the 2-year period, grasses recovered approximately 65 percent of the applied nitrogen at the 100- and 200-pound levels and about 40 percent at the 400-pound level.

Red clover and alfalfa seeded in mixture with timothy and with brome were about equal in yield to grass alone plus 100 pounds of nitrogen in the seeding year and were much superior in the second year. Application of 100 pounds of nitrogen to grass-legume mixtures increased both yield and nitrogen content in the first cutting. In subsequent cuttings, total yield and legume fraction of the yield were often depressed by nitrogen treatment; exceptions were noted where legume stands were weak.

Apparent nitrogen fixation by the legumes was consistently reduced by nitrogen treatment. Vigorous legume stands had an apparent nitrogen fixation of 60 pounds per acre in the seeding year and up to 200 pounds in the second year.

Canada Dept. Agr., Frederiction, New Brunswick, Canada,

Odland, T. E., and Sheehan, J. E. RESPONSE OF POTATOES TO DIFFERENT AMOUNTS OF NITROGEN, PHOSPHORIC ACID AND POTASH WHEN GROWN IN CONTINUOUS CULTURE AND IN ROTATION WITH REDTOP. Amer. Potato J. 38: 33-42. 1961.

An experiment was begun at the Rhode Island Agricultural Experiment Station in 1944 to obtain information on the effect of various amounts and ratios of fertilizer materials on yield and quality of potatoes. In 1951, each plot was divided into 2 sections. On the west half of each plot, a rotation of 2 years of potatoes and 2 of redtop was used. On the east half, potatoes were grown continuously during the 14-year period.

Green Mountain and Katahdin varieties were used, yields were determined, and data on specific gravity and cooking qualities were obtained.

No significant increase in yield of potatoes was obtained when the fertilizer application was increased beyond 1,500 pounds per acre of an 8-12-12 where potatoes were grown continuously. When grown in rotation with redtop, increases in yield were obtained up to 1,750 pounds per acre of the same fertilizer.

No further increase in average potato yields was obtained when more than 130 pounds of nitrogen per acre were applied, including 40 pounds N in cyanamid.

Yields of potatoes were increased when the amount of phosphorus in the fertilizer was increased to 180 pounds of  $P_2O_5$  per acre. No further increase in yield resulted when the amount was increased to 225 pounds per acre. The response to phosphorus was influenced considerably by seasonal weather conditions.

No increase in average yields of potatoes resulted from applications of more than 135 pounds per acre of potash.

The yields of potatoes, when grown in rotation with redtop, were usually 60 to 80 bushels more per acre than when they were grown continuously. The season and whether it was the first or second crop of potatoes, following redtop, had considerable influence on the results.

Growing potatoes in a 2-year rotation with soybeans did not result in sufficient increase in yields over continuous potatoes to justify this rotation.

Average specific gravity of the potatoes decreased when fertilizer applications were increased. There was no consistent increase or decrease in specific gravity when nitrogen in the fertilizer was increased from 130 to 190 pounds per acre. Increases in phosphate tended to increase specific gravity of the potatoes, whereas increases in potash had the opposite effect.

Potatoes grown in rotation with redtop were consistently higher in specific gravity than those grown continuously. No difference in specific gravity resulted from growing potatoes in rotation with soybeans when compared with continuous culture.

For conditions similar to those under this experiment, an application of 1,500 to 1,800 pounds per acre of an 8-12-12 or similar fertilizer is suggested.

R.I. Agr. Expt. Sta., Kingston, R.I.

Nettles, V. F. RESULTS OF FERTILIZER TRIALS WITH SWEET POTATOES. Fla. State Hort. Soc. Proc. 73: 179-183. 1960.

Increases in the rate of application of nitrogen from 20 to 60 pounds per acre in 1956 and from 40 to 100 pounds per acre in 1958 and 1959 resulted in a greater yield of U.S. No. 1 and total marketable grades of sweet potatoes. These yield increases were in a linear manner and were found both on Kanapaha and Arredondo soil types.

Larger harvests of U.S. No. 1 and total marketable sweet potatoes were also obtained in 1958 and 1959 with each increasing increment of potassium from 80 to 200 pounds per acre. A similar increase was noted in 1956 for the U.S. No. 1 grade, but the harvest of the roots of the marketable grade was affected by an interaction of the potassium and phosphorus levels.

In 1957, when only the total yield of the sweet potato crop was obtained, the highest average yield was found on plots receiving 60 pounds of nitrogen per acre. The yield differences obtained from plots receiving increasing increments of potassium resulted in a cubic curve with the highest yields being obtained at 120 and 200 pounds per acre.

The results indicate that, under the present system of applying fertilizer early in the growing season, higher rates of nitrogen and potassium could be efficiently employed than are now generally used.

Fla. Agr. Expt. Sta., Gainesville, Fla.

MacKay, D. C., and Chipman, E. W. THE RESPONSE OF SEVERAL VEGETABLES TO APPLIED NITROGEN, PHOSPHORUS AND POTASSIUM ON A SPHAGNUM PEAT SOIL. Soil Sci. Soc. Amer. Proc. 25: 309-312. 1961.

The N, P, and K requirements of a strongly acid sphagnum peat soil were determined for several vegetable crops over a 4-year period. Six rates of each nutrient ranging from deficiency to excess were applied in a randomized block experiment designed to measure main effects and selected interactions. The analyses of variance indicated that at practical rates of application, interactions were negligible, and the curves of best fit, derived by polynomial regression analyses, characterized the scatter diagrams closely.

Heavy rates of N were necessary for all crops, and there was little indication of reduced requirements at the end of 4 years. Initially, large responses were obtained from small amounts of P. There was some effect from K but less than that generally reported for other organic soils.

Canada Dept. Agr., Kentville, Nova Scotia, Canada.

Alben, A. O. EFFECTS OF AMMONIUM NITRATE, TRIPLE SUPERPHOSPHATE, AND MURIATE OF POTASH ON REACTION OF YAHOLA LOAM IN A FACTORIAL FERTILIZER EXPERIMENT. Soil Sci. 92: 212-214. 1961.

Fertilizer carriers were applied in an experiment of factorial 2x2x2 arrangement over a 10-year period to the appropriate plots at average rates per acre per year of: ammonium nitrate, 183 pounds; 60 percent muriate of potash, 225 pounds; and triple superphosphate, 340 pounds for a pecan orchard. The soil was Yahola 1. Since the fertilizers were broadcast around the trees, they covered approximately one-half the soil area; and the concentration of fertilizers per acre of treated soil surface was thus about double that for the rates applied per acre of orchard. At the end of the 10-year period the pH of the soil in the zone of fertilizer application for all treatments was summarized in the following Table.

Table.--Mean effects and interactions of N, P, and K fertilizers on the pH of Yahola loam at various depths

Fertilizers †	Raising or Lowering of Mean pH		
	0-6 in. pH 7.04	6-12 in. pH 7.45	12-18 in. pH 7.60
N.....	-0.078	-0.065	-0.089*
P.....	-0.416***	-0.202***	-0.096*
N X P.....	-0.074	-0.016	-0.026
K.....	0.122**	0.030	0.035
N X K.....	0.031	0.036	0.060
P X K.....	0.043	0.006	0.005
N X P X K.....	0.009	0.005	-0.007

† N = ammonium nitrate; P = triple super phosphate; and K = muriate of potash.

\* Significant at 0.05; \*\* at 0.01; and \*\*\* at 0.001.

CRD, ARS, USDA, Shreveport, La.

Terman, G. L., DeMent, J. D., and Engelstad, O. P. CROP RESPONSE TO FERTILIZERS VARYING IN SOLUBILITY OF THE PHOSPHORUS, AS AFFECTED BY RATE, PLACEMENT AND SEASONAL ENVIRONMENT. Agron. J. 53: 221-224. 1961.

Corn was grown as a first crop during all four seasons at Wilson Dam, Ala., on limed Hartsells fsl. Mixed and banded applications of 2 ammoniated ordinary superphosphates, concentrated superphosphate, and diammonium phosphate were compared. Second and third crops of corn then were grown without further addition of P.

Millet was grown in spring and summer, wheat in fall and oats in winter for comparison with corn. In all 4 seasons, corn was more responsive to applied P than millet, oats, or wheat grown at appropriate seasons. Limiting yields of corn were not usually attained by the highest rate of application, 180 mg. of P per pot, while the other crops exhibited definite limiting yields. Response by all crops increased in a similar manner with increase in water-soluble P content of the applied phosphates. Because of the indefinite nature of limiting yields for corn forage, it was not possible to establish any specific seasonal effects on response by corn. However, corn appears to be a suitable crop to grow during any season for greenhouse evaluation of P sources.

Banding resulted in greater response than mixing of the phosphates just prior to planting corn. Effects of placement and water solubility were less for the second crop, and there were no appreciable differences in response by the third crop to these variables. Yields of corn during winter were reduced in proportion to the 16-, 24-, and 32 day periods during which the pots were left in a water bath at 52°-55° F. Difference for water solubility and placement were rather pronounced under this condition, but temperature was the major factor limiting yields.

Soil and Fert. Br., TVA, Wilson Dam, Ala.

Two well-characterized crystalline ferric phosphates, two colloidal ferric phosphates, and fluorapatite were tested under greenhouse conditions as sources of phosphorus for corn over a 3-cropping period. The selected compounds are representative of those expected to form in soils as reaction products from more soluble phosphate fertilizers.

Strengite,  $\text{FePO}_4 \cdot 2\text{H}_2\text{O}$ , was completely unavailable in acid soils and gave only a slight phosphorus response on soils limed to pH 7.6. Uptake of P from hydrogen ammonium ferric phosphate,  $\text{H}_8\text{NH}_4\text{Fe}_3(\text{PO}_4)_8 \cdot 6\text{H}_2\text{O}$ , was approximately 70 percent that from MCP, and increased with cropping.

The colloidal ferric phosphates were approximately 78 percent as available as MCP and became more available with liming and cropping. In the soil limed to pH 6.5, their effectiveness increased from 47 percent that of MCP in the first crop to 100 percent as effective by the third crop.

Fluorapatite, included as an insoluble calcium phosphate source, was completely unavailable.

Soils and Fert. Res. Br., TVA, Wilson Dam, Ala.

Ayers, A. S., and Hagihara, H. H. EFFECTIVENESS OF RAW ROCK PHOSPHATE FOR SUGAR CANE. *Soil Sci.* 91: 383-387. 1961.

The availability of raw rock and superphosphates, both banded and mixed with the soil, was compared on phosphorus-deficient soils of pH 4.1, 5.0, and 6.1. The test was conducted in pots of 8 cubic foot capacity and the crop grown for a period of 1 year. Results of the study were summarized as follows:

1. Several-fold increases in yield over the checks were obtained from both forms of phosphate with both methods of placement and on all three soils.
2. Superphosphate mixed with the soil was at least as effective as when localized immediately beneath the seed pieces.
3. Raw rock phosphate mixed with the soil gave significantly greater yields than the same material banded.
4. Where raw rock and superphosphates were both banded, the latter produced higher yields in all instances.
5. Raw rock phosphate mixed with the soil proved as effective as superphosphate similarly applied with two of the soils, but was inferior with the third.
6. Raw rock phosphate mixed with the soil significantly out-yielded banded superphosphate on one soil, gave somewhat better yields on another, and on a third soil was moderately inferior to superphosphate. On a cost per unit  $\text{P}_2\text{O}_5$  basis, raw rock phosphate was superior to superphosphate on all three soils.
7. The availability of raw rock phosphate was found to be inversely related to soil pH as well as to the level of exchangeable calcium and the degree of calcium saturation.
8. Despite extreme deficiencies of soil phosphorus, percent P in the plants was only slightly higher where phosphate was applied than where it was omitted.

Expt. Sta., Hawaiian Sugar Planter Assoc., Honolulu, Hawaii.

Pritchett, W. L., and Swinford, K. R. RESPONSE OF SLASH PINE TO COLLOIDAL PHOSPHATE FERTILIZATION. *Soil Sci. Soc. Amer. Proc.* 25: 397-400. 1961.

Single applications of 0.5 to 2 tons of colloidal phosphate per acre, made at time of planting of slash pine (*Pinus elliottii* Engelm.), resulted in significant increases in tree growth over a 15-year period on Leonfs. Results from replicated treatments, applied in 1945 near Gainesville and Welaka, Fla., indicate the commercial feasibility of fertilizing slash pine on acid "flatwood" soils.

Neither tree survival nor wood density were significantly influenced by treatment. Average dbh and volume per merchantable trees were significantly greater in fertilized plots than in controls at both locations. The best treatment, considering treatment costs and timber value at the end of 15 years, was 0.5 ton of colloidal phosphate per acre applied in alternate 4-foot strips and disked. Cordwood volumes in this treatment averaged 45% greater than in the untreated controls. Disking of the soil following the application of the phosphate material increased yields by about 3 cords per acre over yields obtained from phosphate alone.

Extractable soil phosphorous content of needles from treated plots were higher than from control plots in the Gainesville experiment, but not in the Welaka experiment.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Lutz, J. A., Jr., Terman, G. L., and Anthony, J. L. RATE AND PLACEMENT OF PHOSPHORUS FOR SMALL GRAINS. *Agron. J.* 53: 303-305. 1961.

The average of 11 experiments with small grain forage in Georgia, Mississippi, and Virginia gave no consistent difference in effectiveness for small grain between a 10-20-20 (60% of the P water-soluble) and a 7-14-14 (7% of the P water-soluble). Broadcasting and diskng in these fertilizers to supply 40 pounds of  $P_2O_5$  per acre were 42% as effective as application with the seed, while topdressing after emergence was 33% as effective as applications with the seed. Differences among placements were less in 2 experiments in Virginia for grain production than for forage. Rates higher than 40 pounds of  $P_2O_5$  with the seed caused yield reduction in some experiments. Placement of fertilizers separate from the seed in two other experiments was superior to placement in contact with the seed.

Content of P in the first cutting of forage in six experiments was not consistently affected by placement. Slightly higher content resulted from 80 pounds of  $P_2O_5$  applied with the seed than from lower rates.

On Groseclose sil, P content of the grain was not different for 40 and 80 pounds per acre of  $P_2O_5$ . Diammonium phosphate and concentrated superphosphate applied in contact with the seed resulted in higher P content than separate placement on Groseclose sil, but on Davidson cl, P content was higher with separate than with contact placement.

Va. Polytech. Inst. Blackburg, Va.

Hunter, A. S., Hoffman, E. N., and Yungen, J. A. RESIDUAL EFFECTS OF PHOSPHORUS FERTILIZER ON AN EASTERN OREGON SOIL. *Soil Sci. Soc. Amer. Proc.* 25: 218-221. 1961.

In each of three successive years, a 6-year rotation (barley-3 years alfalfa-corn-sugar beets) was established on separate plots of Owyhee sil treated with 0, 26, 53, 105, and 210 pounds of P per acre and a uniform rate of N. Plots were split in the fifth year for differential N and in the sixth year for P and N treatments.

Yields and removal of P by crops were determined each year. In the sixth year measurements of soluble P in soil, percent P in plant derived from soil P, A-values, and yield and compositional responses of sugar beets to added P fertilizer were employed to evaluate levels of available residual P in soil.

All methods of evaluation indicate that 210 pounds of P were adequate for all crops in the 6-year rotation. Residual P from the 105-pound rate was inadequate for maximum yield of beets. Essentially no residual P remained in the sixth year from the 26- and 53-pound applications.

Accumulation of N by alfalfa was unaffected by initial rate of P. Fertilizer N substantially increased corn yields following 3 years of productive alfalfa.

Tech. Paper 1300, Ore. Agr. Expt. Sta., Corvallis, Oreg.

Simpson, K. FACTORS INFLUENCING UPTAKE OF PHOSPHORUS BY CROPS IN SOUTH-EAST SCOTLAND. *Soil Sci.* 92: 1-14. 1961.

In a series of experiments over a period of 15 years, a study was made of the effect of a number of factors on the uptake of soil and fertilizer phosphorus by plants and its relation to growth and yield of crops. The following conclusions were drawn:

1. Increasing soil temperature by 5° C. over the growing period gave consistent, large increases in soil P uptake but did not greatly affect the uptake of fertilizer P.
2. Decreasing soil moisture tension consistently increased the uptake of fertilizer P by both oats and potatoes, but did not greatly affect soil P uptake when fertilizer was intimately mixed with the soil. In some instances, where fertilizer was placed in a band for potatoes, soil P uptake was increased by lowering moisture tension.
3. The above conclusions together explain the low apparent recovery of fertilizer P in warm, dry seasons found in an early series of experiments.
4. Increasing rate of superphosphate application always gave increases in fertilizer P uptake but very often depressed soil P uptake.
5. There was strong positive interaction between rates of applied N and rate of applied P on the uptake of P. Both soil and fertilizer P uptake were affected.
6. Although on low P soils there was a positive curvilinear relationship between P uptake and potato yield, a negative relationship was found on high P soils.
7. On high P soils, increasing the rate of superphosphate above 28 or 56 pounds  $P_2O_5$  per acre for potatoes brought about delay in tuber development, reduction in yield, and sometimes delay in emergence.

Edinburgh Sch. Agr., Edinburgh, Scotland.

Power, J. F., Brown, P. L., Army, T. J., and Klages, M. G. PHOSPHORUS RESPONSES BY DRYLAND SPRING WHEAT AS INFLUENCED BY MOISTURE SUPPLIES. *Agron J.* 53: 106-108. 1961.

Fertilizer experiments were carried out for 4 years under field conditions on five soils (Daniels fsl, Cushman 1, and three areas of Williams 1) typical of the dryland hard red spring wheat area of the northern Great Plains. Applications of P to fallowed soils often, but inconsistently, resulted in increased grain production. Yield increases due to applications of P were related to the available P in soil prior to seeding, soil moisture at seeding, and the sum of inches of soil moisture at seeding plus precipitation from tillering to heading.

The results suggest that to be successful in dryland areas, soil P test values in the medium range should be evaluated in terms of present and, possibly, expected moisture supplies.

SWCRD, ARS, USDA, Mandon, N. Dak.

Webb, J. R., Eik, K., and Pesek, J. T. AN EVALUATION OF PHOSPHORUS FERTILIZERS APPLIED BROADCAST ON CALCAREOUS SOILS FOR CORN. *Soil Sci. Soc. Amer. Proc.* 25: 232-236. 1961.

Five field experiments were conducted in which several slightly water-soluble P sources were compared with concentrated superphosphate (CSP) for use in broadcast applications for corn. The tests involved rates of 30 and 60 pounds available  $P_2O_5$  per acre and were located on calcareous Webster soils which tested low in available P.

The sources could be ranked into three groups as measured by their effect upon the concentration of P in corn leaves and upon corn yields. CSP and dicalcium phosphate dihydrate were the most effective sources, with the former being slightly superior. Anhydrous dicalcium phosphate, calcium metaphosphate, and a chemical blend of mono- and dicalcium phosphate were of intermediate effectiveness, producing yield increases of about 70 to 80% of that given by CSP. Granular calcium metaphosphate was the least effective source, being about 60% as effective as CSP in promoting yield increases.

It was concluded that on calcareous soils a highly water-soluble source of P, such as CSP, is likely to be more effective in broadcast applications for corn than are most slightly soluble sources. However, other characteristics of the fertilizer may be of equal importance in determining their value. Fertilizer granule size appeared to influence the effectiveness of some of the less soluble sources. It appeared that any advantage of large particles or granules was attained at the expense of some reduction in effectiveness. These trends were evident, despite the fact that the fertilizers were applied in advance of planting and that corn is a relatively long-season crop providing considerable time for fertilizer-soil reaction.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Webb, J. R., Pesek, J. T., and Eik, K. AN EVALUATION OF PHOSPHORUS FERTILIZERS VARYING IN WATER SOLUBILITY: OAT FERTILIZATION. *Soil Sci. Soc. Amer. Proc.* 25: 222-226. 1961.

Nine field experiments were conducted in which phosphorus fertilizers differing in water solubility were compared for the fertilization of spring-seeded oats. Methods of fertilizer application were also studied in five of the experiments. The tests involved rates of 15 to 75 pounds of available  $P_2O_5$  per acre, and were located on soils which tested low in available P and had a pH range from 5.4 to 7.9.

The reaction of the soil appeared to be the most important single factor influencing the effectiveness of P sources and their method of application. In general, the degree of P water solubility assumed most importance in the experiments located on calcareous soils, while placement effects were of greatest significance on the acid soils.

In 3 of 5 experiments located on calcareous soils, there was a definite increase in yields with increasing water solubility of the P sources. However, the data were not comprehensive enough to permit the establishment of any critical level of water solubility.

Drilling the fertilizer with the seed was significantly superior to broadcasting in the three experiments involving placement studies on acid soils. Phosphorus sources differed only slightly in effectiveness on these soils.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Power, J. F., Grunes, D. L., and Reichman, G. A. THE INFLUENCE OF PHOSPHORUS FERTILIZATION AND MOISTURE ON GROWTH AND NUTRIENT ABSORPTION BY SPRING WHEAT: I. PLANT GROWTH, N UPTAKE, AND MOISTURE USE. *Soil Sci. Soc. Amer. Proc.* 25: 207-210. 1961.

The effects of stored soil moisture, seasonal precipitation, and P fertilization upon spring wheat growth were studied in a field experiment under controlled moisture conditions on a Chestnut soil in eastern Montana. Plant growth, grain yields, and nutrient uptake were proportional to available moisture and were increased by P fertilization. A uniform yield increase from P fertilization was measured under all moisture conditions on this relatively low P soil, with no interactions between moisture supplies and P fertilization.

Phosphorus fertilization had no consistent effect upon total moisture use at any stage of growth. However, at soft dough and harvest, P fertilization increased the plant material produced per unit of moisture used. Correlation coefficients between plant growth or nutrient uptake and moisture use were extremely high as the crop approached maturity, for both fertilized and nonfertilized treatments.

SWCRD, ARS, USDA, Sidney, Mont.

Power, J. F., Reichman, G. A., and Grunes, D. L. THE INFLUENCE OF PHOSPHORUS FERTILIZATION AND MOISTURE ON GROWTH AND NUTRIENT ABSORPTION BY SPRING WHEAT: II. SOIL AND FERTILIZER P UPTAKE IN PLANTS. *Soil Sci. Soc. Amer. Proc.* 25: 210-213. 1961.

The availability and uptake of soil and fertilizer P was studied with dryland spring wheat under four moisture regimes in a field experiment in eastern Montana. The Chestnut soil used was moderately low in available P (6.2 p.p.m.  $\text{NaHCO}_3$ -soluble P per acre).

Fertilization with P, higher soil moisture supplies at seeding time, and additional precipitation during the growing season, all increased total P uptake by spring wheat at all stages of plant growth. Interactions between any of these three factors seldom affected total P uptake at any stage of growth.

Increasing the supply of soil moisture at seeding or growing-season precipitation increased plant uptake of soil P. However, P fertilization reduced soil P uptake. Moisture supplies at seeding and growing-season precipitation did not affect uptake of fertilizer P, except at the tillering stage of growth. The percent of total P in plant material derived from fertilizer was generally lowest in treatments receiving the most moisture, either as stored soil moisture or growing-season precipitation.  $\text{NaHCO}_3$ -extractable P was not influenced appreciably by moisture conditions.

SWCRD, ARS, USDA, Sidney, Mont.

Paden, W. R. GROWTH RESPONSE OF COTTON, OATS, AND LESPEDEZA TO VARYING RATES OF POTASSIUM AND SODIUM. *S.C. Agr. Expt. Sta. B.* 488, 35 pp. 1961.

The response of crops to varying rates of potassium application and the ability of certain crops to use sodium as a partial replacement for potassium when the supply of potassium in the soil is low, was studied.

Four soil types (Cecil cl, Cecil sl, Davidson cl, and Iredell 1) were used, and surface soil of these types was transported to Clemson. It was placed in specially constructed concrete frames, each 1/400 acre in size, on Cecil subsoil.

Four of the series were filled with Cecil s1 which was adjusted to and maintained at four pH levels - 5.0, 5.5, 6.0, and 6.5. The other three soil types were maintained at pH 6.5 only.

Some of the more important findings were:

1. Under the system of continuous cropping of cotton with rye grown as a winter cover and green manure crop and only the seed cotton being removed from the soil, there were only small differences in the yields of seed cotton between the different rates of treatments with respect to potassium and potassium plus sodium.
2. The average increases in yields of seed cotton on the Cecil s1 from all treatments combined where the cotton was grown continuously for 6 years were equivalent to 13.0, 19.0, and 21.8 percent for the various pH levels, respectively, over the yields secured at pH 5.0.
3. A characteristic difference in earliness of maturity of the cotton at the different pH levels was observed. This was observable beginning with the seedling stage of growth and continuing through the boll maturity stage with differences of 29.7, 40.8, and 50.5 percent more seed cotton being harvested at the first picking from the respective higher pH levels than at 5.0.
4. The average yields, after the cotton was grown in the rotation with oats and lespedeza, continued to show similar responses at the different pH levels as before. The increases were equivalent to 43.1, 53.6, and 40.9 percent, respectively, over that obtained at the low pH level of 5.0. The decline in yields to 40.9 percent at the pH 6.5 level is attributed to the greater removal of the potassium nutrient from the soil by the increased growth of lespedeza as a result of the more favorable supply of available calcium to the legume.
5. The 1958 yields of seed cotton showed the characteristic responses from the various potassium and potassium plus sodium treatments expected under the system of cropping practices used. The increase of potassium ( $K_2O$ ) to the higher rates of application was reflected in much higher yields of seed cotton. This was true at all pH levels excepting pH 5.0 where the soil was too acid for successful growth of cotton.
6. The yields of oats produced, both grain and straw, from the various treatments at the various pH levels on the different soils showed only very slight differences. It was observed that the oats straw was weaker and lodged more severely where it was grown on plots which received the lower rates of potassium.
7. The lespedeza hay yields, like the yield of oats, showed very little difference between the rates of potassium alone or of the potassium plus sodium treatments. Very significant differences were observed between the average yields of hay produced at the different pH levels on the Cecil s1 soil. The yields were 16.6, 32.0, and 68.2 percent higher at the respective pH levels than at pH 5.0. There was a considerable difference in the quality of the hay produced. It was evident that the variations in available calcium in the soil accounted for the differences in yields and also the quality of hay produced.
8. Data obtained from the chemical analyses of the three crops grown in the rotation provide a source of valuable information of the nutrient requirements of crops.
9. Soil acidity control is of basic importance in a soil fertility program for South Carolina. Soil nutrient balance must be maintained to meet the growth requirements of crops for highest and most efficient production. This requires that adjustments be made wherever necessary through the application of nutrients, which may be the limiting factors in crop growth. Sodium is shown to replace potassium for some crops where the supply of potassium is low.

Potash fertilizers with less than 100 percent water solubility have been produced on an experimental basis by the Tennessee Valley Authority. These fertilizers, called potassium metaphosphate and potassium pyrophosphate, might be of special use to farmers owing to their reduced solubility.

In order to test the idea that excessive uptake of potash could be reduced, potash fertilizers having 25, 45, and 99 percent water solubility were compared with muriate of potash (0-0-60) on alfalfa in a greenhouse test.

Yields of six successive harvests of alfalfa from the experimental fertilizer treatments were almost always equal to those from muriate of potash treatments.

The idea that fertilizers of low solubility would reduce germination damage to seeds was tested. Rates of potash ( $K_2O$ ) from 20 to 500 pounds per acre of the experimental fertilizers were applied in contact with flax seeds at the time of planting in greenhouse pots. The young seedlings were counted and their heights measured on the fourth and eighth day after planting.

Damage to seedlings increased directly with increasing solubility of the fertilizers. Muriate of potash caused seedling damage at rates of 100 pounds of potash ( $K_2O$ ) per acre or more. In some cases at the higher rates, not a single seedling grew. The experimental fertilizer of 25 percent water solubility caused no damage at rates up to 500 pounds of potash ( $K_2O$ ) per acre. The 99 percent and 45 percent soluble fertilizers caused intermediate damage to flax seedlings.

On a potash-deficient soil in the field, corn was fertilized with the experimental materials to determine if they were equal in value to muriate of potash as practical fertilizers. Applications of potash increased corn yields from 28 bushels per acre on untreated plots to 75 bushels on plots treated with 80 pounds of potash ( $K_2O$ ) per acre. In all cases, the yield increases obtained with the experimental fertilizers were the same as those obtained with the use of muriate of potash.

Low water solubility of potash fertilizers is evidently not an important factor in reducing excessive potash uptake by crops; although these materials are equal in value to muriate of potash as practical fertilizers. Low solubility of these fertilizers may be especially useful where high rates of potash and phosphate could be used to advantage in starter fertilizers.

U. Minn., St. Paul, Minn.

Cairns, R. R., and Carson, R. B. EFFECT OF SULPHUR TREATMENTS ON YIELD AND NITROGEN AND SULPHUR CONTENT OF ALFALFA GROWN ON SULPHUR-DEFICIENT AND SULPHUR-SUFFICIENT GREY WOODED SOILS. *Canad. J. Plant Sci.* 41: 709-715. 1961.

Sulphur applied in the elemental form, or as sodium or calcium sulphate, on Grey Wooded soils, increased yields of alfalfa on sulphur-deficient Loon River 1, but not on sulphur-sufficient Garrick 1. The quantity of sulphate-sulphur was extremely low in the alfalfa grown on untreated Loon River 1 and increased markedly as a result of the application of sulphur to the soil. Although herbage from untreated areas of the sulphur-deficient soil contained a slightly higher percent nitrogen in 1955 than that grown on the sulphur-sufficient soil, sulphur treatment increased nitrogen content and yield of nitrogen on the sulphur-deficient soil. The relative abundance of nitrogen in the herbage grown on the check areas of the deficient soil suggests that the main effect of sulphur was not on root

nodulation or nitrogen supply, but rather on nitrogen assimilation and other physiological functions of the sulphur-containing compounds within the plant.

Soil Res. Sub-Sta., Vegreville, Alberta, Canada.

Barrows, H. L., Neff, M. S., Gammon, N. Jr., and Kilby, W. W. THE RESPONSE OF ONE-YEAR-OLD TUNG TREES TO LEVELS AND PLACEMENTS OF ZINC SULFATE AS AFFECTED BY SOIL TYPE. Proc. Amer. Soc. for Hort. Sci. 76: 300-309. 1960.

The effect of soil type and levels and placements of zinc sulfate on the growth and accumulation of zinc and other nutrient elements in 1-year-old tung trees was studied in the fields. The soils were Savannah fsl, Red Bay fs, Lakeland fs, and Arrendondo lfs. The treatments consisted of the factorial combination of three levels of zinc sulfate with three placements and a check plot (no zinc sulfate).

No general recommendation for the control of zinc deficiency can be made for tung growing on all soils, but by working through the medium of leaf analysis and plant growth, recommendations can be made for the four soils tested in this experiment. For example, 1 ounce of commercial zinc sulfate applied on the surface 12 to 17 inches from the tree should supply adequate zinc to young trees growing on the Savannah soil, whereas 4 ounces should be similarly applied for trees growing on the Red Bay soil. Zinc sulfate should be mixed with the Lakeland and Arrendondo soils prior to planting in amounts to give a concentration in the planting zone of 40 p.p.m. of zinc in the Lakeland soil and 80 p.p.m. in the Arrendondo soil.

Total growth and feeding-root concentration in the soil were reduced on all but the Arrendondo soil by mixing the zinc with soil in which the tree was planted and particularly when the high level of zinc was placed in the root zone.

Zinc concentration was higher in trunk leaves and provided a more sensitive measure of zinc uptake than did zinc concentration in lateral leaves. Zinc uptake, as measured by leaf analysis, was greatest when the high level of zinc was mixed with the soil in which the tree was planted. The average concentration of zinc in the roots was about 10 times that in the leaves.

CRD, ARS, USDA, Bogalusa, La.

Salter, P. J., and Haworth, F. THE AVAILABLE-WATER CAPACITY OF A SANDY LOAM SOIL: II. THE EFFECTS OF FARMYARD MANURE AND DIFFERENT PRIMARY CULTIVATIONS. J. Soil Sci. 12: 335-342. 1961.

The effects of annual application of farmyard manure and of different cultivation treatments for a 6-year period on the available-water capacity of a sandy loam soil were measured. It was shown that the farmyard manure applications have led to a significant increase in the available-water capacity of the soil. The cultivation treatments influenced the available-water capacity to a lesser extent.

It is suggested that the reason why many previous workers have failed to detect an increase in available-water capacity in comparable experiments is that they did not use sufficiently accurate methods for the determination of field capacity and the permanent wilting percentage, i.e., the upper and lower limits of the available water in the soil.

National Veg. Res. Sta., Wellesbourne, Warwick, England.

The 1954-59 average yields show that high yields of continuous corn were grown on Ednia sil when heavily fertilized. Continuous corn yields surpassed those from a corn-oat-meadow rotation where little or no N fertilizer was added. The evaluation of the N supplied to the two cropping systems in the 1957 season was somewhat confounded by a nonuniform moisture condition between cropping systems. In this case, the rotation corn, which had the advantage of 2 inches more available subsoil moisture than the highly fertilized continuous corn, yielded more than the continuous corn. Although the moisture conditions were uniform between cropping systems in 1958, the excessively wet condition in midseason apparently was a disadvantage to the rotation corn.

Estimates of the amount of N provided by the meadow crop ranged from 123 to 200 pounds per acre in 1957 and from 54 to 83 pounds per acre in 1958. Where 30 pounds of fertilizer nitrogen were added to the rotation corn, the estimates of nitrogen provided to the crop varied from 168 to 187 pounds per acre in 1957 and from 97 to 125 pounds per acre in 1958. The estimates of the continuous corn treatments, where 30, 60, and 120 pounds of nitrogen were applied, were higher than the actual treatments. Where 240 pounds of N were applied to continuous corn, the estimates were usually lower.

In comparing the efficiency of the two N sources, the rotation corn yields were within the 95% confidence belt for the continuous corn N function in all cases but one. The exception occurred with one comparison in the 1957 data, the year in which the rotation corn had the advantage of 2 additional inches of available soil moisture. In all other cases in this experiment though, the hypothesis that the benefit from the meadow crop was due solely to N could not be rejected.

Total C analyses of the 0- to 6-inch and 6- to 12-inch layers of soil and total N analyses of the 0- to 2-foot layer showed that high rates of N applied to continuous corn had increased organic matter levels over the amount contained in soils taken from the continuous corn check plots in 1953. Levels of organic matter in the rotation corn plots in 1958 were intermediate between those of the 1958 highly fertilized continuous corn and the 1953 continuous corn check plot levels.

Jr. Author, Iowa Agr. Expt. Sta., Ames, Iowa.

### Salinity and Alkali Problems

Sandoval, F. M., Carlson, C. W., Mickelson, R. H., and Benz, L. EFFECTS OF RUN-OFF PREVENTION AND LEACHING WATER ON A SALINE SOIL. *Canad. J. Soil Sci.* 41: 207-217. 1961.

A 4-year study was conducted on the effects of precipitation management on salt movement and spring wheat yields on an imperfectly drained saline silt loam in the northern Red River Valley of North Dakota. Partial leaching by artificially applied water at the beginning of the experiment was compared to leaching benefits by impounded precipitation. Average monthly water table fluctuated from 2 to 11 feet with rainfall and was usually lowest in late winter or spring and highest during the summer. Average yearly precipitation is 20 inches.

Impounded precipitation was found effective in partially desalinizing the soil. Summer rain was more effective than winter precipitation. Wheat yields were inversely related to soil salinity with the highest correlation coefficients occurring on spring time data for the 6- to 16-inch depth.

SWCRD, ARS, USDA, Mandan, N. Dak.

In a series of studies of plant growth in large tanks at Riverside, Calif. the following results were obtained:

1. Barley grown in comparatively large tanks at Riverside, Calif., and irrigated with a bicarbonate-containing water of low total salt content and low Na percentage resulted in relatively low  $\text{HCO}_3$ , Cl, and Na in the drainage in a 6-year period.
2. The Na percentage was exceptionally low in the drainage obtained after 3 years of barley growth, owing largely to Ca and Mg brought into solution by the products of microbiological action. Following the last year of barley growth, the Na percentage was still somewhat less than in the irrigation water, largely because of the absorption of Na by the barley plants.
3. The absorption and transpiration of water by Sudan grass for 7 consecutive years without drainage resulted in a soil solution more than 12 times as concentrated as the applied irrigated water.
4. Owing to the relatively low sulfur requirements of Sudan grass, the concentration of  $\text{SO}_4$  became 50 or more times that of the applied water. The differential rates of absorption of other ions resulted in considerable change in the ratios of soluble ions in the irrigation water.
5. Bicarbonate disappeared from solution in much greater amounts, both relative and absolute, than any other component of the applied water, but only about 40 percent of the  $\text{HCO}_3$  was converted into  $\text{CaCO}_3$ . The greater part of the remainder was lost by volatilization.
6. Following the growth of Sudan grass, Na percentage in the drainage was, in most cases, considerably greater than in the irrigation water. Differences in the absorption of Na by barley and Sudan grass accounts for the different effects of Na percentage.
7. The absorption of Cl by Sudan grass amounted to about 80 percent of the Cl applied in the irrigation water.
8. The overall effect of water and ion absorption by plants, and the precipitation of  $\text{CaCO}_3$ , was to produce a soil solution markedly different in chemical character from that of the irrigation water.
9. The pH of the drainage was substantially higher than that of the irrigation water, probably due to precipitated  $\text{CaCO}_3$ .
10. Three practically important lessons flow from these studies (1) The results strongly indicate the absolute necessity for substantial leaching wherever irrigation is practiced in semi-arid regions; (2) the required leaching cannot safely be left to the idiosyncrasies of natural precipitation, except possibly in areas of relatively high rainfall; and (3) the preceding statement applies wherever the least saline irrigation water is applied, but the necessity for leaching becomes, of course, increasingly urgent as the salinity of the applied water increases. The absolute amount of leaching necessary to prevent salt accumulation also increases as the salinity of the applied water rises, but it probably varies from soil to soil owing to variations in the pore spaces of the soil.
11. Predictions based on the analysis of irrigation water concerning ionic concentrations that will result in the soil solution are subject to strong limitations where crops are grown. This is especially true where moderately saline irrigation water is used.

U. Calif. Citrus Expt. Sta., Riverside, Calif.

Soluble salts tend to accumulate in soils in arid regions and are a potential hazard wherever irrigation is practiced. Plant response is primarily determined by the osmotic pressure of the soil solution to which the electrical conductivity of the saturation extract of soils is closely enough related to provide a useful index of salinity. Specific ion effects, involving nutrition or direct toxicity, affect certain crops under some conditions. Climate, irrigation frequency, and other management practices may modify the salt tolerance of plants. Varietal differences in salt tolerances are not usually of practical importance for most crops, but rootstock specificities regulating the accumulation of potentially toxic ions are of major importance for many fruit crops. Because soil management factors profoundly influence the degree of salt accumulation, plant response to a given irrigation water cannot be predicted without taking into account the probable effects of the conditions under which the water will be used on the resultant level of soil salinity. Soil solutions are often five or ten times more concentrated than the applied irrigation water. The use of more saline water requires that larger quantities of water be applied to promote leaching and to minimize the relative degree of salt accumulation in the root zone of the crop.

In this study the author concluded that:

1. Plant response to salinity is governed primarily by the osmotic pressure of the soil solution, although specific ion effects may be important for some crops under certain conditions.
2. Inhibition of growth by salinity can often be reduced by more frequent irrigation, that is, by keeping the soil moisture at a higher level. Saline soils generally should be irrigated at higher residual soil moisture levels than comparable nonsaline soils.
3. Different varieties of a given crop usually have similar salt tolerance; a few exceptions are noted. Some rootstocks or varieties of fruit crops can restrict the uptake of ions (chloride, sodium, borate) to which these crops are specifically sensitive.
4. Irrigation with saline waters requires the application of extra quantities of water to promote leaching of salt through the soil, and to prevent a progressive accumulation of salt in the root zone.
5. Crop response to salinity can be adequately described in terms of the electrical conductivity of saturation extracts of soils and the concentration of toxic ions in the root zone. Because the level of salt accumulation in the soil from the use of a given irrigation water can be quite variable, it is not possible to predict crop response to an irrigation water without taking into account the conditions under which it is to be used.

SWCRD, ARS, USDA, Riverside, Calif.

Ehlig, C. E. EFFECTS OF SALINITY ON FOUR VARIETIES OF TABLE GRAPES GROWN IN SAND CULTURE. Proc. Amer. Soc. for Hort. Sci. 76: 323-331. 1960.

Black Rose, Cardinal, Perlette, and Thompson Seedless varieties of grapes were grown in sand culture with a nutrient solution to which was added 1-atm. mixed chlorides, 2-atm. mixed chlorides, 2-atm.  $\text{CaCl}_2$ , 2-atm.  $\text{NaCl}$ , 2-atm.  $\text{Na}_2\text{SO}_4$  or no salt. Chloride accumulation from high chloride treatments caused burn on leaf blades of all varieties. Injury developed very rapidly at temperatures above 100° F., but very slowly at temperatures below 90° F. Treatments containing large amounts of calcium in addition to chloride were much more injurious than the  $\text{NaCl}$  treatment. Black Rose and Cardinal were much more sensitive

to chloride than Perlette and Thompson Seedless because they accumulated chloride two to three times faster. All varieties were injured by chloride earlier with each succeeding season. High concentrations of sulfate in the  $\text{Na}_2\text{SO}_4$  treatment caused magnesium deficiency symptoms on all varieties.

Salinity reduced vine growth but growth was adequate on all treatments where chloride injury did not cause vines to deteriorate. Excessive growth caused lower fruit production on the non-saline treatment than on the saline treatments. Yields of all varieties on the 2-atm. salt treatments averaged about 30 to 45 pounds per vine except for Black Rose and Cardinal on the mixed chloride and  $\text{CaCl}_2$  treatments where vines died or nearly died.

SWCRD, ARS, USDA, Riverside, Calif.

Harding, R. B., and Ryan, T. M. SOIL SALINITY AND WATER DISTRIBUTION UNDER NONTILLAGE AND TILLAGE IN A DIFFERENTIALLY FERTILIZED, IRRIGATED CITRUS ORCHARD. Proc. Amer. Soc. for Hort. Sci. 77: 155-166. 1961.

The influence of nontillage and tillage, various fertilizers, and irrigation water distribution upon the distribution of soluble salts in the soil was studied in long-term citrus fertility trials.

$\text{NaNO}_3$  and  $(\text{NH}_4)_2\text{SO}_4$  treatments resulted in the highest amounts of soluble salts in the soil, while  $\text{Ca}(\text{NO}_3)_2$  treatments resulted in less salinity than other fertilized plots, both under nontillage and tillage. Under nontillage, furrows adjacent to tree rows had low amounts of salinity even in treatments receiving  $\text{NaNO}_3$  or  $(\text{NH}_4)_2\text{SO}_4$ . Under tillage, furrows adjacent to the north side of trees were high in salinity while furrows adjacent to the south side of the trees were lower in salinity under the  $\text{NaNO}_3$  and  $(\text{NH}_4)_2\text{SO}_4$  treatments.

Surface accumulations of salts in furrow ridges were extremely high under nontillage with  $\text{NaNO}_3$  and  $(\text{NH}_4)_2\text{SO}_4$ . Even  $\text{Ca}(\text{NO}_3)_2$  treatments under nontillage had considerable accumulation of salts in the center ridges. With all treatments there was evidence of salt accumulation in soil under furrow ridges, and it often extended to at least the 4-foot depth. Accumulations of salt in the surface foot of furrow ridges of tilled treatments were not as high as nontilled treatments, due to redistribution of salts by tillage. In general, there were increased amounts of soluble salts in the soil near the center of the irrigated middles.

Measurements of water distribution showed that nontilled plots received about twice as much water as tilled plots. About 78% of the irrigation received by nontilled plots and 61% of that received by tilled plots was applied in the 2 tree furrows. The rest of the irrigation water was distributed to the 3 center furrows. Other than tree furrows, there were relatively small differences in amounts of water received between nontilled and tilled treatments. Furrows adjacent to the south side of trees received more water than furrows adjacent to north sides of trees. In tilled plots, the former received about twice that of the latter. In nontilled plots, the differences were not as great.

Salt distribution in the soil showed a definite inverse relationship to water distribution. In this study the downward movement of water from furrows was primarily vertical and little leaching of salts occurred as a result of a horizontal water movement. Capillary movement of water from furrows to raised inter-furrow ridges and its subsequent evaporation resulted in marked accumulation of salts in furrow crests.

U. Calif. Citrus Expt. Sta., Riverside, Calif.

Lunin, J., Gallatin, M. H., and Batchelder, A. R. EFFECT OF STAGE OF GROWTH AT TIME OF SALINIZATION ON THE GROWTH AND CHEMICAL COMPOSITION OF BEANS: II. SALINIZATION IN ONE IRRIGATION COMPARED WITH GRADUAL SALINIZATION. *Soil Sci.* 92: 194-201. 1961.

The effect of the growth of beans of a given amount of salt applied in a single irrigation was compared with that of the effect of the same amount of salt applied in two or more irrigations.

Gradual salinization initiated at pre-planting was more inhibitory than like salinity levels introduced abruptly at later stages of development. Attempts to precondition the plant by gradual salinization were unsuccessful when yield was used as a criterion.

Transpiration was affected primarily by the soil solute suction at the time of measurement, whereas yields, moisture content, and cation accumulation were also significantly influenced by the stage of growth at which salinization occurred. Preconditioning affected these variables only insofar as the plant was exposed to a certain degree of salinity for a longer time.

The introduction of the salinity factor at various growth stages not only complicates the plant-water relationship but other growth factors as well.

SWCRD, ARS, USDA, Norfolk, Va.

### Cover Crops and Green Manure Crops

Flocker, W. J. SPRING REMOVAL BY WINTER COVER CROPS OF MOISTURE FROM A COMPACTED SOIL. *Proc. Amer. Soc. for Hort. Sci.* 76: 705-709. 1960.

Most vegetable crops need a fine seed bed--which is difficult to achieve with compacted soil. An important cause of soil compaction is tillage with heavy equipment in the spring, when the soil moisture is high from winter snows and rains. Compaction is less with lighter equipment or drier soils. The possibility of using winter cover crops to reduce soil moisture is given.

Little is reported in the literature on the use of winter cover crops to use soil water accumulated during these months of high rainfall. The present study was conducted to evaluate various winter cover crops in ability to remove excess soil water from mechanically compacted plots. This problem is especially important in areas of extensive vegetable production. Many of the high-value vegetable crops are produced on irrigated soils and harvested when soil moisture contents are high, which leads to excessive soil compaction during the summer and early fall. The following conclusions were reached from the three year study on soil compaction:

1. Operating heavy equipment over the soil causes compaction as measured by increases in bulk density. Susceptibility to compaction is greatest when the soil moisture is near field capacity. The depth to which compaction occurs appears to be restricted to the surface 6-8 inches and no measurable increase in density occurred at the 12-inch depth. Compaction caused by equipment traffic is largely alleviated during the winter, but the effect of annual fall traffic seems cumulative.
2. The compaction treatment increases the number and density of clods.
3. Traffic-induced compaction reduced infiltration of water. Infiltration rate was largely restored by the following spring, but, as with bulk density, the effect of the treatment seems cumulative.
4. The type of cover crop had no significant effect on bulk density.

5. Soil compaction reduced yields of legume crops to the point that they could not be recommended to alleviate a compacted soil condition. Cereal grasses and sod grasses proved to be more efficient producers on compacted plots than any other cover crop tested.
6. All depths considered, sod grasses lowered soil moisture content during the winter more than the other grasses tested. Any type of cover crop was superior to none. From the standpoint of cover crop yields and their effects on soil moisture content, soil bulk density, infiltration rates, and cloddiness, alone, one could recommend cereal grasses as the type of winter cover crop to use over a considerable range of climatic and soil conditions.

U. Calif., Davis, Calif.

### Climatic Influence

Soulides, D. A., and Allison, F. E. EFFECT OF DRYING AND FREEZING SOILS ON CARBON DIOXIDE PRODUCTION, AVAILABLE MINERAL NUTRIENTS, AGGREGATION, AND BACTERIAL POPULATION. *Soil Sci.* 91: 291-298. 1961.

Laboratory experiments showed that when either drying and freezing was followed by incubation there was an increase in the decomposition substantially higher for drying than it was for freezing. Wetting a dry soil in air or in vacuum showed little difference in carbon dioxide evolution. Prolonged drying increased the rate of decomposition in the soil organic matter, and multiple dryings had a cumulative effect. Multiple freezings had no effect.

While drying and freezing per se had an adverse effect on the stability of soil aggregates, decomposition of the organic matter of soil over a long period appeared to improve aggregation.

Drying caused a release of ammonia nitrogen and resulted in increased nitrification in comparison with untreated and with frozen soils.

Drying was more destructive to bacteria than freezing. With both treatments the rate of bacterial destruction was highest during the growth phase, decreasing to negligible proportions at the decline phase.

The increased decomposition of the soil organic matter following intermittent drying or freezing is due primarily to the release of nutrients, especially energy sources, that can be rapidly oxidized by the soil flora. The bursts of  $\text{CO}_2$  production following drying or freezing at the initial period of incubation is probably enhanced by the youthful state of the growing bacterial population.

SWCRD, ARS, USDA, Beltsville, Md.

Van Arsdel, E. P., Riker, A. J., Kouba, T. F., Suomi, V. E., Bryson, R. A. THE CLIMATIC DISTRIBUTION OF BLISTER RUST ON WHITE PINE IN WISCONSIN. *Lake State Forest Expt. Sta., Sta.* Paper 87, 34 pp. 1961.

In certain large areas of southern Wisconsin where the alternate hosts were common and rust had been omnipresent on ribes bushes, the white pines were, nevertheless, generally free of infection. Blister rust behavior on favorable and unfavorable sites were studied to provide a means for estimating the pine infection probability on a given site.

Individual trees examined in an area in Rock County (southern Wisconsin) with abundant ribes showed that the blister rust cankers occurred less than 5 feet above the

ground. Cankers were limited to pine trees in openings in the forest canopy and in a kettle hole.

In systematic samples of white pine associated with ribes in southern and lowland western Wisconsin, blister rust was most often found in sheltered valleys. It occurred on 54 percent of the plots at the bases of slopes and 38 percent of those in small (D/H less than 1.0) forest openings. Larger openings and a closed forest had rust present less often. Only one-twentieth of the samples at the shoulders of slopes showed rust present.

A site formula based on the above factors was prepared. This predicted rust canker locations with 89-percent accuracy in southern and western Wisconsin at elevations below about 1,000 feet in that area with an average July temperature of more than 70° F.

Studies of local variation in temperature and moisture distribution indicated that the bottoms of narrow valleys were under 68° F. for a longer period than level ground was, and that the shoulders of valleys were warm longer than either the valley or level ground. The bases of slopes were cool, somewhat like a valley, but the effect was less pronounced. A kettle hole averaged cooler than flat land sites. Openings in the forest with diameters less than the height of surrounding trees were under 68° longer than sites in the open or under the forest canopy.

High humidities were more common near the ground; the bottoms of narrow valleys had higher humidities, and kettle holes averaged more moist than flat land sites. Small openings in the forest were more humid and had saturated air more hours per day than did sites in the open field or in unbroken woods.

Northern Wisconsin had general blister rust distribution on pine with rust present on almost all sites. The lowest rust presence (68 percent of plots) was under tree canopy overstories.

There were indications that rust distribution was fairly well correlated with average July temperatures. As July temperature averages increased, rust was usually confined to locally cool moist places.

Lake States Forest Expt. Sta., FS, USDA, St. Paul 1 Minn.

### Surface Soil Removal

Engelstad, O. P., Shrader, W. D., and Dumenil, L. C. THE EFFECT OF SURFACE SOIL THICKNESS ON CORN YIELDS: I. AS DETERMINED BY A SERIES OF FIELD EXPERIMENTS IN FARMER-OPERATED FIELDS. *Soil Sci. Soc. Amer. Proc.* 25: 494-497. 1961.

The effect of surface soil thickness on yields of corn was studied to learn whether nitrogen fertilizer would substitute for surface soil thickness in producing yields of corn on the minimal Brunizem soils of southwestern Iowa.

During 1957 and 1958, 55 nitrogen fertilizer experiments were distributed over the existing range of surface soil thickness. The corn yield obtained from each of 5 nitrogen fertilizer rates was measured at each site. By means of a multiple regression analysis it was found that application of nitrogen fertilizer at the rate of 100 pounds per acre for corn completely substituted for surface soil in 1957 but failed to do so in 1958. Apparently, climatic factors influence the degree of such substitution.

J. Paper J-3990. Iowa Agr. and Home Econ. Exp. Sta., Ames, Iowa.

Engelstad, O. P., and Shrader, W. D. THE EFFECT OF SURFACE SOIL THICKNESS ON CORN YIELDS: II. AS DETERMINED BY AN EXPERIMENT USING NORMAL SURFACE SOIL AND ARTIFICIALLY-EXPOSED SUBSOIL. *Soil Sci. Soc. Amer. Proc.* 25: 497-499. 1961.

In an experiment involving corn yield responses to rates of nitrogen fertilizer on artificially exposed Marshall subsoil and normal surface soil, results were obtained in 1958 and 1959 which indicated that equal corn yields could be obtained on either surface or subsoil, provided that adequate nitrogen fertilizer was supplied. Maximum corn yields on both subsoil and normal soils were approximately 100 bushels per acre in 1958 and 125 bushels per acre in 1959. Yields on subsoil control plots were 45 to 50 bushels per acre lower than from corresponding surface soil plots. A regression analysis of the data indicated that the production of maximum corn yields on subsoil required 35 more pounds of nitrogen per acre in 1958 and 52 more pounds of nitrogen per acre in 1959 than on normal soil. Nitrogen availability in the untreated surface soil exceeded that in the untreated subsoil by the equivalent of about 70 to 75 pounds of fertilizer nitrogen per acre per year.

J. Paper J-3991, Iowa Agr. and Home Econ. Exp. Sta., Ames, Iowa.

Reuss, J. O., and Campbell, R. E. RESTORING PRODUCTIVITY TO LEVELED LAND. *Soil Sci. Soc. Amer. Proc.* 25: 302-304. 1961.

Field and greenhouse fertilizer tests on subsoils of the Yellowstone Valley which had been exposed by land leveling operations indicate that these subsoils are very deficient in N and P. This conclusion is substantiated by soil analyses. In the greenhouse, yields of barley on untreated subsoil were low, but excellent yields resulted when both N and P were supplied. Nitrogen alone was not effective. Excellent yields of corn were obtained in the field when adequate N and P were supplied or where heavy rates of manure were plowed down. Field response to N alone was good but generally less than that obtained by the combination. Phosphorus used alone did not increase crop yields. Neither physical properties nor minor elements were found to be limiting.

SWCRD, ARS, USDA, Huntley, Mont.

Heilman, M. D., and Thomas, J. R. LAND LEVELING CAN ADVERSELY AFFECT SOIL FERTILITY. *J. Soil and Water Conserv.* 16: 71-72. 1961.

A tract of Hidalgo soil in Texas was leveled in 1957. Half the block was cut to an average depth of 0.5 foot and the other half was filled. This soil is moderately supplied with available nutrients and is very calcareous throughout the profile.

After leveling, three crops of forage sorghum were grown for soil improvement. The first sorghum crop was fertilized with 200 pounds of ammonium sulfate per acre applied to the cut area. Oven-dry forage yield in 1957 was 3,485 pounds per acre less on the cut area than on the fill area in spite of the fertilization of the cut area. The yields for the cut and fill areas were 5,924 and 9,409 pounds per acre, respectively. In 1959 the cut area produced 11,200 pounds per acre of forage whereas the fill area produced 14,020 pounds per acre. The three crops of sorghum did not materially change the productivity differential between the cut and fill but had considerable value as a soil improving crop for forage yields increased with each succeeding green manure crop.

Soil samples for chemical analyses were taken in March, before the forage sorghum was planted in April 1959. These analyses showed that the cut area had a much lower nutrient level than did the fill area (table 1). Nitrate nitrogen in the fill area was double the amount of nitrate in the cut area. The different levels had an effect on both sorghum yield and nitrogen fertilizer response.

Table.--Availability of Nitrogen and Phosphorus in Cut and Fill Areas of a Leveled Field in 1959<sup>1</sup>

Soil characteristics	Cut	Fill
	Pounds/Acre	Pounds/Acre
Nitrate nitrogen.....	53.6	93.2
Mineralizable nitrogen <sup>2</sup> .....	135.4	160.6
Phosphorus available .....	16.0	24.3
Soluble salts .....	1228.0	1112.0

<sup>1</sup> Available nutrients in the first 3 feet of soil.

<sup>2</sup> 14 day incubation with initial nitrates excluded.

Sorghum yields and the nitrogen content of the sorghum were significantly increased by the application of nitrogen fertilizer to the cut area. There was no significant increase in sorghum yields from the application of nitrogen fertilizers to the fill area, although the nitrogen content of the forage was increased.

Percentage nitrogen recovery from nitrogen fertilizer was greater on the cut (40 percent) than on the fill area (8 percent). No increase in yield was gained from a high rate of nitrogen application on the fill area. The cut area would require 345 pounds of nitrogen per acre to produce yields equal to that produced on the nonfertilized fill area.

The difference between the cut and fill area is still reflected in the growth of Sudangrass following four soil improving crops and a cabbage cash crop.

SWCRD, ARS, USDA, Welaco, Tex.

Nelson, J. L., and Crawford, C. L. FERTILIZER NEEDS OF LEVELED LAND IN THE COLUMBIA BASIN. Wash. Agr. Expt. Sta., Sta. C. 368, 4 pp. 1960.

Development of a typical Columbia Basin Project farm unit includes extensive land leveling in preparation for irrigation. Approximately 90 percent of the irrigable land in the Basin is surface irrigated. Most of this land must be leveled to some degree. "Cuts" and "fills" of 3 to 4 feet are not uncommon. After leveling, the land usually irrigates well, but often little or nothing will grow on the severely cut areas for several years.

From 5 to 50 percent of a farm unit may be affected by poor crop growth because of leveling. Most serious effects are usually found where more than a foot of soil has been removed or where a fill of more than a foot has been made with subsoil from the second foot or deeper.

These areas present difficult problems in establishing experimental plot because of their small size, irregular shape, and great variability. Some field experiments have been completed and a large number of soil samples have been taken at varying depths for soil tests.

The authors give the following recommendations:

1. Nitrogen--None of the virgin soils of the Columbia Basin furnishes more than about 40 lbs. of N per acre per year to field crops. Thus, most of the N required by the crop (except legumes) must be applied as fertilizer. The nitrogen furnished to crops by subsoils may be slightly less than to surface soils, but not enough less to materially affect the N fertilizer requirement.
2. Phosphorus--Available phosphorus can be expected to be very low on deep cuts. This can be determined with a soil test, taking separate samples from cuts and noncuts. Applications of phosphorus of 100 to 250 lbs.  $P_2O_5$  per acre may be required on heavy cuts to overcome the deficiency. This sometimes can be accomplished by going over

the whole field once with a normal fertilizer setting, going over the fills, and light cuts twice, and the heavy cuts three times. These cut areas in the field can be located by leveling maps or by crop appearance after the first year.

3. Potash--A soil test is the best guide to possible potash deficiencies on cut areas. Where the soil test indicates a need for potash for such crops as potatoes and vegetable crops, 50 to 100 lbs. of K<sub>2</sub>O per acre will probably suffice.
4. Zinc--Most of the soils in the Columbia Basin increase in lime with depth. Since lime makes soil zinc less available, almost all subsoils will be zinc deficient for susceptible crops such as beans, onions, potatoes, and corn. An application of 10 lbs. of actual zinc per acre, plowed under, should correct the deficiency from 3 to 5 years.
5. Other Minor Elements--All other essential nutrients have been applied without effect on cut areas.
6. No amount of fertilizer can correct cut area problems where cuts are made very close to, or into, coarse sand, gravel, caliche, or rock. The usual major problem in these cases is to keep the scalped spots from drying up. Lighter but more frequent irrigations sometimes help.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Grunes, D. L., Brown, L. C., Carlson, C. W., and Viets, F. G., Jr. LAND LEVELING: IT MAY CAUSE ZINC DEFICIENCY. N. Dak. Farm Res. 21(11): 4-7. 1961.

Where surface soil was removed to aid gravity irrigation, severe zinc deficiency of corn and mild zinc deficiency of potatoes were observed. The acid soluble zinc in the exposed subsoils was low. Plant tissues sampled from the zinc deficient areas were also low in zinc.

Zinc sulfate applied either to the soil, or as a spray on the plants, cured the zinc deficiency. Manure (20 tons per acre) was also effective.

N. Dak. Agr. Expt. Sta., Fargo, N. Dak.

### Mulching

Menn, J. P. PLASTIC MULCHES. Fla. State Hort. Soc. Proc. 73: 114-117. 1960.

Polyethylene because of its low cost in comparison with other plastics and its flexibility and toughness is now being used extensively to form mulching film materials.

Polyethylene film is very durable, very flexible, non-brittle, light in weight, very impermeable to water vapor, and moderately impermeable to gas transmission. When pigments and stabilizers are added, the film becomes stable in sunlight and can be made to reflect or absorb sunlight. Clear polyethylene film will degenerate in sunlight while the black films (carbon black added) will not. Outdoor weatherability studies have shown black film to be good to excellent.

Polyethylene film of a minimum of 1.5 mils is necessary, if the film is going to be used from 1 year to the next. A film of this dimension is sturdy enough to tolerate rubber-tired equipment moving over it. The black film will not disintegrate in the soil and thus cannot be incorporated in the soil as can the organic mulches.

Mulching with clear film can raise soil temperatures from 10 to 15 degrees depending upon soil type, thus stimulating early plant growth and fruit set. The clear film will also conserve soil moisture since water vapor cannot penetrate it to any great amount. Weed growth is also greatly enhanced under the clear film, and if a grower desires a mulch to control weeds clear film is not at all suitable. The air temperature under the clear film will be so greatly increased that it can kill the germinating plants when air temperatures are high. When one uses clear film as a mulch, it has a greenhouse effect over the soil area.

The black polyethylene film is the type of film most widely used for mulch purposes. Black polyethylene film will prevent the germination and the growth of weeds from 90 to 100%. The use of black polyethylene mulch film can have many effects on the soil temperature underneath the film. Under conditions of direct sunlight the soil temperature can be raised as much as 25° to 30° F. More common temperature elevations of soil range from 5° to 15° F. Under other conditions with less direct sunlight, the soil temperature can be lowered by the increased retention of moisture and an evaporative-recondensing cycle under the film. In cooler climates, the soil temperature can be raised 5° F. to increase early germination and to provide a shorter time to maturity. If the climate is normally quite hot, the soil temperature rise of 15° to 25° F. can be a retarding influence on growth. Most of this soil temperature change occurs in the upper 1 to 2 inches of soil profile. The specific crop, the climatic conditions, and the season should be taken into account to provide the best conditions for the beneficial use of black mulch film.

Table.--Characteristics of Mulching Materials

Characteristics	Sawdust	Straw	Manure	Black paper	Black polyethylene
Longevity . . . . .	Decomposes about 1/2- 3/4 per year	Not more than one year	Not more than one year	One growing season or less	Two or more years.
Water retention (reduction of surface evaporation) . . . . .	Good	Poor	Poor-fair	Good	Good (Impervious to water).
Heat absorption . . . . .	Poor	do	Poor	do	Good.
Soil heat retention . . . .	Fair	do	Fair	do	Do.
Weed control . . . . .	do	do	Poor	do	Excellent.
Water penetration. . . . .	Good	Good	Good	Fair-poor	None.
Fertilizer value. . . . .	Poor	Poor	do	None	Do.
Extra nutrients needed for decomposition. . . . .	Nitrogen	Nitrogen	None	None	Do.
Toxic qualities. . . . .	Usually none	None	Possibility, if applied too heavily	If oil, tar, or creosote impregnated	Do.
Incidence of rotted fruit over nonmulched plants. . . . .	Lower	Unknown (probably lower)	Unknown	Lower	Lower.
Cleanliness of fruit. . . . .	Good	Good	Poor	Excellent	Excellent.
Durability (can it be walked on?) . . . . .	do	Poor	Poor	Poor	Good.
Effect on soil structure. . . . .	Poor	Good	Good	Unknown	Excellent.
Appearance of mulch. . . . .	Good	Poor	Poor	Good	Good.

Chipman, E. W. STUDIES OF TOMATO RESPONSE TO MULCHING ON RIDGED AND FLAT ROWS. *Canad. J. Plant Sci.* 41: 10-15. 1961.

Black plastic and sawdust mulches were applied to ridged and flat rows in a 2-year (1956-1957) study of their effect on tomato culture. Records were taken of soil temperature and moisture levels, ripe fruit to August 31, and total crop (ripe and green fruit).

The highest early yield was obtained from the unmulched and sawdust plots but the heaviest total yield came from the black plastic plots. Highest soil temperature and lowest moisture readings were recorded under the black plastic, and lowest soil temperature and highest moisture under the sawdust.

The earliest ripe fruits came from the flat rows, but the total crop was significantly higher on the ridge rows. There was no significant interaction for mulches and row type.

Canad. Dept. Agr., Kentville, Nova Scotia, Canada.

Agricultural Research Service. APPLIED MULCHES AND MULCHING. U.S. Dept. Agr., Agr. Res. Serv., ARS 22-71, 12 pp. 1961.

Many growers are interested in the possibilities of applied mulches for maintaining and improving soil conditions and increasing farming efficiency and crop yields. But despite the longtime use of mulches by gardeners and nurserymen--and to a lesser extent by farmers--mulch farming has not been extensively developed in the United States, and pertinent information about mulching is not readily available in all localities.

This report brings together information from various sources to help agricultural leaders answer questions of growers regarding mulching and the various mulches in the light of experiments and experience under conditions similar to those prevailing in their area.

The broad patterns of the general effects of mulching on crops and soils under varying conditions in this country are discussed in the first section. The second section deals in more detail with particular types of mulches, their uses, and limitations.

Since up-to-date information on stubble mulching and crop residue management is already available in publications issued by the Agricultural Research Service of the U.S. Department of Agriculture and by the States, this report deals primarily with applied mulching. A list of publications dealing with various aspects of mulching is given.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hanks, R. J., Bowers, S. A., and Bark, L. D. INFLUENCE OF SOIL SURFACE CONDITIONS ON NET RADIATION, SOIL TEMPERATURE, AND EVAPORATION. *Soil Sci.* 91: 233-238. 1961.

Investigations were made to determine the influence of straw, black-painted gravel, aluminum-painted gravel, and plastic mulches on net radiation, soil temperature, and evaporation. Net radiation was highest on the black treatment followed by the plastic-covered, check, straw-covered, and aluminum-painted gravel treatments. Soil temperature was highest under the clear plastic treatment, followed by the check, black-painted, aluminum-painted, and straw-covered treatments, respectively. Evaporation was greatest on the check plot but was about equal on all of the other treatments. The total difference in

evaporation over the year between the check and other treatments was no more than 1 inch of water.

There was no direct relationship between net radiation or soil temperature and evaporation. This is probably due to the great limiting influence of soil moisture within the soil after the soil surface dries.

SWCRD, ARS, USDA, Manhattan, Kans.

Webster, G. R. THE EFFECT OF SAWDUST, STRAW, COMPOST AND MANURE ON THE YIELD AND CHEMICAL COMPOSITION OF STRAWBERRIES AND ON SOIL MOISTURE, ACIDITY AND ORGANIC MATTER CONTENT. *Canad. J. Plant Sci.* 41: 42-49. 1961.

Sawdust, straw, compost, and manure were applied under dryland conditions to strawberry plantings at two locations. The effects on yield, leaf nutrient content, soil moisture, soil acidity, and soil organic matter content were evaluated. Sawdust mulch and sawdust incorporation, the former being slightly better, produced highly significant increased yields over the check treatment and were superior to all other treatments. Soil moisture measurements showed that the sawdust treatments conserved soil moisture. This was regarded as the chief reason for the increased yields. The nitrogen, phosphorus, potassium, calcium, and magnesium contents of leaves were affected somewhat by the treatments but the levels were considered adequate in all cases.

Soil acidity was significantly increased in the sawdust plots but this was attributed to the additional nitrogen applied rather than to the sawdust *per se*. Sawdust incorporation, manure, and compost treatments significantly increased soil organic matter content when compared to the check treatment.

Canada Dept. Agr., Saanichton, British Columbia, Canada.

## PLANT MANAGEMENT

### Pastures And Haylands

Dennis, R. E., Hamilton, K. C., Massengale, M. A., Schonhorst, M. H., Erie, L. J., Halderman, A. D., Amburgey, L. R., Stanberry, C. O., Tucker, T. C., Nielson, M. W., Tuttle, D. M., Keener, P. D., and Shields, I. J. ALFALFA: FOR FORAGE PRODUCTION IN ARIZONA. U. Ariz., Coop. Ext. Serv., and Agr. Expt. Sta. BA-16, 36 pp. 1961.

This is a "Culture and Care" bulletin on the raising of alfalfa for forage production in Arizona and covers varieties, production practice, and control of weeds, insects, and disease.

Alfalfa is the most important forage crop grown under irrigation in Arizona. Forage yields of this palatable and nutritious forage crop range from 2 to 12 tons per acre. Length of growing season, variety, irrigation, management, temperature, quality of water, and soil fertility are factors accounting for most of this variation.

When alfalfa is managed properly and full stands are maintained, returns in dollars per acre make it competitive with most field crops in Arizona. Yields from other crops usually are increased when placed in the rotation following alfalfa. Alfalfa improves soil structure, aeration, drainage, and increases the organic matter and nitrogen content of the soil.

U. Ariz., Tucson, Ariz.

Burger, A. W., and Campbell, W. F. EFFECT OF RATES AND METHODS OF SEEDING ON THE ORIGINAL STAND, TILLERING, STEM DIAMETER, LEAF-STEM RATIO, AND YIELD OF SUDANGRASS. *Agron. J.* 53: 288-291. 1961.

Two 2-year studies were conducted at Urbana, Ill., on the effect of rates and methods of seeding on the yield, tillering, leaf-stem ratio, original stand, and stem diameter of sudangrass as follows: (1) Piper sudangrass seeded at 12, 18, and 24 pounds of seed per acre in broadcast, 4-, 8-, and 16-inch drilled rows, 1956 and 1957, and (2) Wheeler, Piper, Sweet, and Greenleaf sudangrass seeded at 12, 24, 36, and 48 pounds per acre respectively, in 8-inch drilled rows, 1958 and 1959.

The following results were obtained: (1) The number of primary culms increased with increasing seeding rate and decreased with increasing row width in the drilled plots. The average original stand count in broadcast plots was much lower than that for drilled plots over all seeding rates. (2) In the first harvest, tillering showed the same linear relationship with rates and methods of seeding, as did the original stand above. Differences in tiller counts which were observed in the first harvest were not sustained in either the second or third harvest. (3) The average stem diameter of the original primary culms in broadcast plots was much greater than in drilled plots. Tiller stem diameter in broadcast plots was much greater than that of similar stems in drilled plots in the first harvest. This significant difference in tiller stem diameter was not sustained in either the second or third harvest. (4) The leaf-stem ratio of broadcast sudangrass was greater than that of the drilled sudangrass in the first harvest. This difference was not sustained in either the second or third harvest. And (5) drilled sudangrass produced more herbage than broadcast sudangrass. No significant differences in yield were found between different row widths or rates of seeding in drilled sudangrass regardless of variety seeded.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Brown, R. H., Beaty, E. R., McCreery, R. A., and Powell, J. D. COASTAL BERMUDAGRASS UTILIZATION: SOILAGE VS. CONTINUOUS GRAZING. *J. Range Mangt.* 14: 297-300. 1961.

At the Americus Plant Materials Center, Americus, Ga., an area of established Coastal Bermudagrass was divided into four paddocks of 1 acre. During the season each paddock was well fertilized and irrigated when 50% of the available moisture was removed. The test was initiated May 13 and terminated on September 17. Two treatments were tested; (A) continuous grazing and (B) soiling (moving and feeding of forage in the green state). Treatments were duplicated. Animals were allowed to graze continuously at will on the assigned paddocks. Animals receiving soilage were fed in the morning at approximately 9:30 to 10:00 and again in the afternoon between 5:00 and 6:00.

The following conclusions were reached: (1) Animals consuming Coastal Bermudagrass as soilage continued to gain weight until early September while animals conventionally grazed performed erratically after the first 28 days; (2) per acre beef production of Coastal Bermudagrass was 948 pounds when fed as soilage and 457 pounds when grazed continuously; and (3) low summer gains of animals grazed continuously was probably due to fecal contamination of the forage and accumulation of mature forage.

J. Paper 153, Ga. Agr. Expt. Sta., Athens, Ga.

Robocker, W. C., Gates, D. H., and Kerr, H. D. EFFECTS OF 2,3,6-TRICHLOROBENZOIC ACID AND CULTURAL TREATMENTS ON SURVIVAL OF DALMATIAN TOADFLAX AND ESTABLISHMENT OF SIBERIAN WHEATGRASS. Weeds 9: 620-625. 1961.

Dalmatian toadflax (Linaria dalmatica) was treated with applications of 0, 1, 2, and 3 lb/A of 2,3,6-TBA in combination with no cultural treatment, mowing, one disking, and two diskings on experimental plots established near Spokane, Washington, in the summer of 1958. The plots were seeded to Siberian wheatgrass (Agropyron sibiricum) in December 1958.

Both Dalmatian toadflax and Siberian wheatgrass increased with intensity of cultural treatments. The increase in Siberian wheatgrass was statistically significant. Highly significant increases of both established toadflax and wheatgrass plants occurred with increasing rates of 2,3,6-TBA. Interaction of cultural and herbicidal treatments was also significant. The increase in numbers of toadflax and wheatgrass plants was due largely to survival of seedlings of both species as a result of seedbed preparation and partial control of downy brome (Bromus tectorum) by the 2,3,6-TBA.

The combination of 2,3,6-TBA and cultivation did not materially change the total vegetative cover of the experimental site. Adverse effects of cultivation on some species were offset by beneficial effects of 2,3,6-TBA in aiding establishment and persistence of other species. The stand of downy brome was reduced by 2,3,6-TBA.

CRD, ARS, USDA, Pullman, Wash.

Kay B. L., and Street, J. L. DRILLING WHEATGRASS INTO SPRAYED SAGEBRUSH IN NORTHEASTERN CALIFORNIA. J. Range Mangt. 14: 271-273. 1961.

Wheatgrass was successfully established following the killing of sagebrush with 2,4-D with a minimum of disturbance to the site. Seed was planted between dead sagebrush plants with a rangeland drill. Sagebrush was not removed.

Establishment was excellent in years when production of the associated resident annuals was high. Median production of resident annuals is about that experienced during the first 2 years of this study. It appears that drilling wheatgrass seed directly into an area of dead sagebrush is a good risk in the area studied.

Agr. Expt. Sta., U. Calif., Davis, Calif.

Hardin, J. W. POISONOUS PLANTS OF NORTH CAROLINA. N.C. Agr. Expt. Sta. B.414. 128 pp. 1961.

A study of the poisonous plants of North Carolina. The advantages of a manual based on an intensive study of the plants of a limited area such as a state are twofold. First, it provides a better knowledge of the distributions and habitats within the state. Second, it simplifies the problem of identification by the elimination of numerous species not occurring in the area. In addition, this intensive study has uncovered a number of problems concerned with the understanding of certain species and their relationship. These problems will form the topics of future research.

The information concerning the poisonous principle, animal symptoms, and treatments has been compiled from the literature. The descriptions and illustrations of the plants, and data on habitats and distributions have come from the author's notes taken during the 3-year study period.

Agr. Expt. Sta., N.C. State Col., Raleigh, N.C.

## Rangelands

Lusk, W. C., Jones, M. B., Torell, D. T., and McKell, C. M. MEDUSAHEAD PALatability. *J. Range Mangt.* 14: 248-251. 1961.

Numerous reports have indicated that the weedy annual grass, medusahead, is unpalatable and has lowered rangeland carrying capacity wherever it has invaded. A grazing test was conducted with sheep to investigate the palatability of medusahead on fertilized and unfertilized annual range. The results indicated that: (1) Sheep, given a free choice, did eat medusahead as long as it was green; (2) sheep held in a small plot area ate some medusahead even when it had headed out and dried; (3) heavy grazing in the spring resulted in a thinned stand of medusahead at maturity as compared to a dense stand of medusahead resulting from light or no grazing; and (4) fertilized medusahead was grazed more than unfertilized medusahead since a greater amount of medusahead was taken from the fertilized plots early in the season. This resulted in less medusahead on the grazed-fertilized areas late in the season as compared to grazed-unfertilized areas.

Jr. Author, CRD, ARS, USDA, Davis, Calif.

White, E. M. A POSSIBLE RELATIONSHIP OF LITTLE BLUESTEM DISTRIBUTION TO SOILS. *J. Range Mangt.* 14: 243-247. 1961.

Little bluestem occurrence on the microridges and not on the microvalleys of a wavy gilgai soil pattern in semiarid western South Dakota seems to be caused by fertility differences of the soils. Little bluestem apparently can compete successfully with western wheatgrass on the infertile microridge soils. Microridge soils are weakly developed and are similar to soils on steep slopes where little bluestem frequently is abundant. Soil fertility may be the most important factor in little bluestem distribution on clay-textured soils. Other factors, including the possible presence of a germination inhibitor in the soil or in the roots of associated species, were studied but did not appear to influence the distribution of the species.

S. Dak. Agr. State Col., Brookings, S. Dak.

Hyder, D. N., Booster, D. E., Sleva, F. A., Sawyer, W. A., and Rodgers, J. B. WHEEL-TRACK PLANTING ON SAGEBRUSH-BUNCHGRASS RANGE. *J. Range. Mangt.* 14: 220-224. 1961.

A planting machine that will operate satisfactorily on soft, plowed seedbeds, which often cause seeding failures with conventional seeders, has been developed in Oregon. The planting mechanism, designed to produce a specific seed-soil relation found desirable in basic research, is a simple and direct fulfillment of wheel-track planting. The machine largely eliminates the problem of planting depths and obtains approximately an optimum seed-soil relation for assurance of successful germination, emergence, and survival of crested wheatgrass. The new seeder, which has been accepted for testing by the Inter-Agency Range Seeding Equipment Committee, will be called the Oregon Press Seeder.

CRD, ARS, USDA, Corvallis, Oreg.

Since sodium from halogeton can alter the chemical and physical properties of soil, information is needed concerning the effect of altered soils on the emergence of various species of grasses and forbs.

Soils which supported whitesage, shadscale, and saltsage vegetation types were treated with halogeton mulch under greenhouse conditions. Eight perennial grasses, 4 annual grasses, and 4 forbs were planted in the treated soil and the emergence and height of the seedlings were recorded after 2 weeks.

Sodium and perhaps potassium appear to be the water soluble materials responsible for reducing the emergence and growth of the species tested. One inch of the mulch (27,000 pounds per acre air-dry weight) and three inches of mulch (95,000 pounds per acre air-dry weight) reduced the percent emergence and height growth of most perennial and annual grasses. One inch of mulch on the saltsage soil increased the percent emergence of all forbs except sweetclover and reduced slightly the height growth of all forbs. Under the 3-inch treatment percent emergence of tall wheatgrass, bassia, and Russian thistle was reduced about 45 percent while the emergence of halogeton was reduced an average of only 24 percent. On the saltsage soil treated with 3 inches of mulch, the emergence of halogeton was 182 percent.

The study indicates that soils altered by halogeton leachate are more favorable for halogeton and other low value or worthless forb species than for desirable grass species. Of the 3 soils used, the saltsage soil appears to be most favorable for germination and emergence of halogeton.

Nev. Agr. Expt. Sta., Reno, Nev.

Gray, J. R., and Goodsell, W. D. CATTLE RANCHES; ORGANIZATION COSTS, AND RETURNS SOUTHWESTERN NONMIGRATORY GRAZING AREA, 1940-59. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. 1, 42 pp. 1961.

Cattle herds on commercial family-operated ranches varied in size in the Southwestern Non-migratory Grazing Area from 80 to 640 head. The data presented represent averages per ranch.

Size of the average ranch increased from 7,676 acres in 1940 to 11,100 acres in 1959. Neither land grazed under permit nor pastureland rented on a per head basis are included as part of the total land in ranch. Leased acreages remained fairly constant. Most of the increase in average size of ranch resulted from purchase of lands by ranch operators.

Cattle numbers per ranch on January 1 varied from 213 head in 1940 to 227 head in 1952. Based on the number of calves raised per 100 cows and heifers 2 years old and over in the herd on January 1, the calf crop varied from 71 to 82. Average marketing weights of calves varied from 332 to 324 pounds. These production rates appeared to increase during or following periods of favorable precipitation, 4 of which occurred during the 1940-59 period. Similarly, net turnoff of beef per cow ranged from approximately 300 to 420 pounds. Turnoff of beef also increased in or after periods of favorable weather.

On the basis of total weight sold, sales of calves made up about 49 percent of total sales, yearlings 20 percent, and mature cattle 31 percent. By this measure, sales of calves increased by 13 percent from 1940-44 to 1950-59. Sales of yearlings dropped 32 percent, and sales of mature cattle gained 7 percent.

The estimated value of investment per ranch was high relative to livestock ranches in other areas. It averaged about \$36,000 in 1940 and about \$158,000 in 1959. Investments in real estate varied from 68 to 82 percent of these total amounts. Livestock investment per ranch ranged from about \$8,000 in 1940 to about \$40,000 in 1952. Investments in machinery, feed, and supplies were insignificant when compared with the total investment. A part of the investment resulted from heavy expenditures during the period for range improvements.

Cash receipts per ranch varied from about \$4,000 in 1940 to more than \$18,000 in 1951. Nearly all of the cash receipts on these ranches are from the sale of cattle. Payments for range improvements were the largest item of miscellaneous receipts, but even payments from this source have made up a very small part of the total cash receipts.

Taxes on real estate and personal property, although rather modest when compared with taxes on farms of equivalent size in other agricultural areas, have been a constant and increasing expense on southwestern cattle ranches.

In general, net income per ranch has been fairly modest on southwestern cattle ranches. Good prices for cattle and favorable weather have seldom coincided. After incomes reached moderately high levels in 1942 and 1943, expenses rose faster than receipts, reducing net ranch incomes to lower levels. Favorable prices for beef cattle starting in 1947 permitted net ranch income to increase sharply, from about \$2,400 in 1946 to \$4,100 in 1947, to about \$6,500 in 1948 and 1949, and finally to a high plateau of about \$9,200 in 1950, 1951, and 1958. Extremely high costs in 1951 and 1953, plus a sharp 2-year break in cattle prices, caused net incomes to drop to about \$1,100 in 1952 and caused a net loss of \$500 in 1953. Costs, prices, and income per ranch improved slightly in 1954, but the severe drought in 1956 resulted in a record 20-year low in net ranch income.

Gross ranch production varied from 77 percent of the 1947-49 average in 1956 to 118 percent in 1959. Costs adjusted for changes in price level varied from an index of 92 in 1942 to 125 in 1953. Efficiency of production was indicated by measuring these deflated costs, or inputs, against production, or outputs. Index of production per unit of input ranged from 69 in 1956 to 114 in 1959. Production per unit of output was highest in years of or following favorable weather.

The index of prices received varied from 37 in 1940 to 152 in 1951 (1947-49 = 100). The index of prices paid varied from 46 in 1940 to 130 in 1959.

ERS, USDA, Inform. Div., Washington 25, D.C.

Staff Writer. CATTLE WALKWAYS IN MARSH RANGE. Land and Water Contract. 3(7): 9-11. 1961.

Coastal Louisiana stockmen are using this conservation practice to open vast new acreage to winter forage at relatively low cost. The practice is dragline-built cattle walkways, man-made high ground to provide livestock with access routes into the marsh. By building a mile of walkway, usually at a cost of less than \$2,000, a stockman can open up a whole half section of virgin marsh rangeland. Often he can connect existing high ground with roadlike earth fill structures and open up a vast new range at little cost.

The benefits of cattle walkways are many and varied. They open up new areas to grazing, and by proper spacing and the use of gates, fences, and other controls on the walkways themselves, grazing can be distributed uniformly over a large range. Cattlemen have found that livestock will graze the wet range for approximately one-quarter of a mile from the man-made high ground.

Walkways serve as bed grounds, calving areas, and feeding sites. They offer livestock some relief from mosquitoes, a serious pest in marsh areas during the summer months. By standing on the walkways the animals expose themselves to the gulf breeze and are able

to protect themselves better. The extra elevation of the levee-like structures also serves as a refuge from high water during storms and unusually high tides.

Walkways make livestock handling easier. Cattle herd readily along the elevated strips. Fewer horses are required for roundup, and for each horse eliminated another cow can be added to the herd.

The much-used high ground and its adjacent water-filled borrow pits create an adequate fire barrier, and afford access for fighting wild fire. Benefits to wildlife are significant. Each mile of walkway construction creates approximately 2.5 acres of open water in the borrow pits. These become ideal habitats for ducks, muskrats, and other marsh creatures.

Land and Water Contract., P. O. Box 2268, Montgomery, Ala.

Holt, G. A., and Wilson, D. G. THE EFFECT OF COMMERCIAL FERTILIZERS ON FORAGE PRODUCTION AND UTILIZATION ON A DESERT GRASSLAND SITE. *J. Range Mangt.* 14: 252-256. 1961.

Two commercial fertilizers, ammonium phosphate and ammonium nitrate, were applied in pelletized form on a typical desert grassland site at rates providing 25, 50, and 100 pounds of nitrogen (N) per acre. A marked response was apparently facilitated by the 14.34 inches of rainfall (5 inches above normal) that fell during the summer.

Total forage production, grazing use, and length of green-feed period were measured as indicators of the effectiveness of fertilization.

Results and conclusions are summarized as follows:

1. At all three rates of application, plots fertilized with either ammonium phosphate or ammonium nitrate showed significant increase in total forage produced over the unfertilized plots.
2. Both fertilizers, even at the lowest rates, almost doubled the forage production over that produced on the unfertilized areas.
3. Plots fertilized with ammonium phosphate showed a linear response in forage production. Plots fertilized at the rates of 25, 50, and 100 pounds of nitrogen per acre produced significantly different means of 4,578, 5,420, and 6,380 pounds of air dry forage, respectively.
4. Plots fertilized with ammonium nitrate reached a point of diminishing return near the 100 pounds of nitrogen per acre application.
5. Cattle utilization at the 25, 50, and 100 pound nitrogen application rates was approximately three, four, and five times as great, respectively, as on the check plots.
6. Cattle showed no preference for one grass species over another on plots fertilized with either ammonium phosphate or ammonium nitrate as contrasted with marked preferences on unfertilized range.
7. Application of the two commercial fertilizers extended the green-feed period of the forage up to 6 weeks.

The highly significant results obtained from this 1-year study indicate that range fertilization has a definite possibility of becoming one of the most valuable tools of range management in southern Arizona.

Tech. Paper 644, Ariz. Agr. Expt. Sta., Tucson, Ariz.

Effects on seedling emergence of initial moisture content, location and magnitude of compacting pressures, depth of covering, and surface crusting were studied. In some experiments, moisture levels were maintained at the initial level. In other experiments, soil drying occurred. With static medium to high moisture levels, pressures of 1 p.s.i. on loose soil caused significantly greater emergence than no pressure. Pressures of 20 p.s.i. were not detrimental when no appreciable soil drying occurred. However, when compaction pressure or surface slaking caused drying soil to develop considerable rigidity emergence was hindered. Greatest emergence through a depth of 1/2 inch of loose soil occurred at about 1/3 atmosphere soil moisture tension.

Jr. Author, SWCRD, ARS, USDA, Bushland, Tex.

### Plant Materials

Schwendiman, J. L., Douglas, D. S., and Hafenrichter, A. L. LATAR ORCHARDGRASS FOR CONSERVATION IN THE WEST. U.S. Dept. Agr., Prod. Res. Rpt. 54, 8 pp. 1961.

Latar orchardgrass was developed for its high quality as feed when used with legumes for hay, pasture, and silage.

The outstanding features of Latar are late heading, leafiness, and low lignin (fiber) content. These features make it especially well suited for use with alfalfa. Many other orchardgrasses head early and become coarse by the time alfalfa is ready to cut. Latar is usually not beyond the early heading stage when alfalfa reaches the proper stage for making hay. The Latar-alfalfa mixture gives high yields and contains enough grass for soil and water conservation.

Under irrigation the Latar-alfalfa mixture also produces high yields.

Many alfalfa-grass and Ladino clover-grass mixtures using Latar orchardgrass are grown on farms in soil conservation districts in the West. Cooperators report that their livestock prefer this mixture to hay mixtures using common orchardgrass. They also note that the Latar recovers more rapidly after cutting than other orchardgrass. The same thing is true of Latar in Ladino clover-orchardgrass mixture when pastured.

Latar is replacing other orchardgrasses in conservation seedings where perennial legume-grass mixtures are used in soil-improving crop rotations or for hay, pasture, or silage. It requires deep, fertile, moderately permeable silt loams or well-drained clay loams with a pH range of about 6.0 to 7.5. It grows well on sandy loams when irrigated. It needs at least 20 inches of precipitation in subhumid areas and season-long water when grown under irrigation. It should not be used in short rotations with annual or biennial legumes, in orchard cover crops, or in waterway seedings.

Latar produces good seed crops for a late-maturing grass. It produced 700 pounds of clean seed per acre under optimum conditions at Pullman, Wash. The same field produced an average of 250 pounds of seed per acre for 7 consecutive years. Latar has produced 10 to 15 percent less seed than the early orchardgrasses.

This is a complete "Culture and Care" report on Latar Orchardgrass.

SCS, USDA, Inform. Div., Washington 25, D.C.

Nine varieties and strains of winter vetch were grown in experimental trials during 4 years (1955-58) at Fayetteville, Marianna, Stuttgart, and Hope, Ark. Three varieties and strains of winter peas and eight of lupine were included in the experimental trials during the same period at Marianna, Stuttgart, and Hope.

The varieties and strains were evaluated for dry herbage production at early, medium, and late spring cutting dates, for seed production, and for winter injury in each of the years that they were grown.

Auburn and Lana woollypod, Madison, Hairy, and Doark were the leading varieties and strains of vetch in herbage production at Fayetteville, on Zaneville sil, at the early and medium cutting dates, Madison and Doark vetch produced the highest herbage yields at this location at the late cutting date.

At Marianna, on Calloway sil, Madison and the three woollypod varieties of vetch, Austrian winter and Romack peas, and common white lupine were similar in herbage production at the early and medium, cutting dates. Romack peas and common white lupine produced the highest yields of dry herbage at the late cutting date at this location.

On a loessial terrace soil (Crowley sil) at Stuttgart, Lana woollypod vetch was the leading variety in dry herbage production at all three cutting dates. Dry herbage yields of Austrian winter and Romack peas and Oregon and Auburn woollypod vetch averaged from 500 to 1,000 pounds per acre less than for Lana woollypod vetch at this location.

Common white lupine produced significantly higher yields of dry herbage than any of the other 19 winter legume varieties and strains at all three cutting dates at Hope on a Coastal Plain soil (Ruston sil). Dry herbage yields of this variety at the early cutting date were approximately equal to those obtained 2 weeks later at the medium cutting date from Madison and the three woollypod vetches and to those obtained 4 weeks later at the late cutting date from hairy vetch and Austrian winter peas.

Common white lupine was the outstanding winter legume variety in seed production, yielding an average of 1,910 pounds per acre for the 4-year period at three locations. The Chilton white, bitter blue, Borre sweet blue, Florida No. 2 blue, and hardy white varieties and strains of lupine yielded an average of 1,079, 986, 863, 846, and 841 pounds of seed per acre, respectively, for the three locations.

Seed yields of Madison, Doark, and Willamette vetch averaged 548, 380, and 308 pounds of seed per acre, respectively, for the four locations. Average seed yields of all of the other vetch varieties and strains were less than 250 pounds per acre.

Romack produced the highest seed yields of the three winter pea varieties and strains, averaging 483 pounds per acre for the 4-year period at three locations.

Winter injury ratings indicated that all of the vetch varieties and strains included in the experimental trials, except purple, can be grown safely anywhere in Arkansas.

Austrian winter and Romack peas escaped serious winter injury at three locations (Marianna, Stuttgart, and Hope) when they were grown on soils with good surface drainage, but the Popago variety was injured severely by winter conditions at both Marianna and Stuttgart, even on soils with good surface drainage.

The three white lupine varieties and strains (Chilton, common, and hardy) were similar to Austrian winter and Romack peas in winter hardiness. Winter injury ratings indicated that all three of the blue lupine varieties and strains (Borre sweet, Florida No. 2, and bitter) were considerably less winter hardy than the white lupines. The two yellow strains (imported and domestic) were injured severely by winter conditions at all three of the locations where they were grown.

On soils with poor surface drainage, less winter injury occurred when the winter legumes were planted on beds.

Winter injury tended to be less severe in thick stands than in thin stands.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Young, R. A., and Haun, J. R., (Key to genera by F. A. McClure). BAMBOO IN THE UNITED STATES: DESCRIPTION, CULTURE, AND UTILIZATION. U.S. Dept. Agr., Agr. Hbk. 193, 74 pp. 1961.

The gradually increasing interest in bamboo among American farmers, gardeners, and commercial users has made it desirable to bring together the essential information available concerning the types of bamboo that give most promise of value in the United States as sources of economic products or as ornamentals. Bamboo is so different in character, habits of growth, and culture from any other crop plant with which the American agriculturist is acquainted that it is necessary to provide a detailed description of the unique nature of bamboo as a basis for its utilization in agriculture. Brief mention is made of the two native bamboos of the Southeastern United States, and a more detailed description of the important species of hardy oriental and of some tropical kinds that have been introduced into cultivation during the past 75 years is given. Information on the propagation, culture, and utilization of bamboos is given.

ARS, USDA, Inform. Div., Washington 25, D.C.

Wiebe, G. A., and Reid, D. A. CLASSIFICATION OF BARLEY VARIETIES GROWN IN THE UNITED STATES AND CANADA IN 1958. U.S. Dept. Agr., Tech. B. 1224, 234 pp. 1961.

Barley ranks fourth in importance among the cereal grain crops grown in North America. The diversity of climate and soil types in the United States and Canada require the growing of many adapted varieties of barley for profitable farming or industrial use. About 165 varieties are grown in the United States and Canada, and these vary greatly in their adaptation to different areas and kinds of farming. This large number of varieties frequently leads to confusion in names and in proper identification. There is need, therefore, for a classification system that will standardize names and insure proper identification of varieties with which the growers or barley processors are concerned. The most profitable returns to the grower result from the use of the best variety available.

The preference of the malting trade and other industrial concerns for certain varieties often necessitates the identification of varieties from threshed grain. This is a difficult task, as usually only kernel characters and such additional characters as may be found on fragmentary spike parts remaining in the threshed grain can be used. The task may be complicated further by mixtures arising in storage and shipping, and often only an approximate identification is possible.

The first comprehensive classification of the barley varieties grown in the United States and Canada was published in 1946 by Åberg and Wiebe.

The present bulletin retains all the varieties in the first publication that are still of commercial importance and, in addition, includes all the new varieties released since 1945.

ARS, USDA, Inform. Div., Washington 25, D.C.

Grass seed production can be a profitable enterprise for many South Dakota farmers.

A large market for grass seed will continue to develop in the Midwest and Great Plains because: (1) The practice of pasture renovation is increasing; (2) the advantages of including grasses in rotations are being recognized as a means of maintaining soil structure; (3) more intensive use of western range and pasture lands demands large-scale renovation practices; and (4) continuing retirement of cultivated land to grass as a means of restricting surpluses can be expected. Certified seed of outstanding varieties will command premium prices and cost little more to produce than uncertified seed.

As with every enterprise, there are problems. To be successful, the producer must be alert to these and manage so as to minimize the hazards. The important considerations necessary to successfully produce grass seed are discussed.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Fulkerson, R. S., and Tossell, W. E. ROW WIDTH AND SEEDING RATE IN RELATION TO SEED PRODUCTION IN TIMOTHY, (PHLEUM PRATENSE L.). Canad. J. Plant Sci. 41: 549-558. 1961.

Row widths of 14, 21, 28, and 35 inches gave similar seed yields, outyielding the 7-inch row width by 109 pounds per acre over a 4-year period. Row width had only minor effects on seed quality measured by seed weight, percentage of seed that established normal seedlings in soil, and early seedling height. Rows 21 inches and wider required weed control measures. Based on seed yield, seed quality, and weed control, the 14-inch row spacing was superior.

Seeding rates of 2.5, 5, 7.5, and 10 pounds per acre had no important effects on seed yield or seed quality. Of the three yield components studied--spike number, spike length, and seed weight--only the last two were correlated with seed yield. Spike number was not related to seed yield in any of the 3 years in which it was studied but may have been important in determining differences among years in seed yield. None of the indices of seed quality was related closely to seed yield.

Ontario Agr. Co., Guelph, Ontario, Canada.

Winch, J. E., and Macdonald, H. A. FLOWER, POD AND SEED DEVELOPMENT RELATIVE TO THE TIMING OF THE SEED HARVEST OF VIKING BIRDSFOOT TREFOIL (LOTUS CORNICULATUS). Canad. J. Plant Sci. 41: 523-532. 1961.

Investigations into pod and seed development and flowering habit relative to the timing of the seed harvest of birdsfoot trefoil were conducted from 1953 to 1956 at Ithaca, New York.

The process of pod and seed development was divided into three stages: pod elongation, seed development, and seed maturation. Only the last stage was of importance in determining the optimum time for seed harvest. Indicators of this stage were the succession of pod colors: light green, green-white, and golden brown. Since these colors indicate changes

in seed viability and pod moisture content they were the basis of determining when an individual pod should be harvested. While light green pods contained seed which was high in germination percentage, it was not until pods turned a green-white that seed attained its maximum weight. Pods of this color were high in moisture, did not dehisce, and should be harvested.

Seed developed in the lowest or oldest three umbels accounted for approximately 92 percent of the potential yield. Any increase over this figure brought about by a delay in harvest which would permit the younger umbels to reach maturity would be overwhelmingly offset by seed loss resulting from dehiscence of the older umbels.

The optimum time of seed harvest may be determined by count or estimate of seed pod maturity. When 60 percent of the pods are light green to white-green in color the crop may be considered to be in the early stages of ripening. When 85 percent of the pods are golden brown a large number will readily dehisce under conditions of low humidity. Birdsfoot trefoil seed harvest should begin when 70 to 80 percent of the pods are mature.

Jr. Author, Cornell U., Ithaca, N.Y.

## Woodlands

Della-Bianca, L., and Olson, D. F., Jr. SOIL-SITE STUDIES IN PIEDMONT HARDWOOD AND PINE-HARDWOOD UPLAND FORESTS. *Forest Sci.* 7: 320-329. 1961.

A comprehensive study of physical soil-site factors affecting site index of five important timber species was conducted in upland Piedmont forests. The trees and soils were sampled in 153 mixed pine-hardwood and hardwood stands representing an advanced stage of ecological development. Yellow-poplar, white oak, scarlet oak, black oak, and shortleaf pine were measured in various overstory mixtures of two to seven dominant species per plot.

Of the 63 soil and site variables considered in initial trials, 15 promising ones were evaluated in detailed multiple regression solutions for each species. All possible combinations of 1, 2, and 3 soil-site variables were analyzed jointly with total age of trees.

The resulting equations were not strong predicting equations. They indicated that models used for soil-site investigations in subclimax softwood types will not produce useful guides for these climax forests. In the Piedmont, few hardwood stands develop by invasion of open land, but gradually infiltrate into pine forests on soil of above average quality. The use of hardwood-dominated forests in the Piedmont for soil-site study also precludes fire, grazing, erosion, and destructive cutting. Limitations on plot selection imposed by natural development impose a similar limitation on use of the soil-site equations. They cannot be extended to apply to recently abandoned fields and severely disturbed woodlands.

The findings provide some important facts about forest soil condition that affect height growth of the species studied. Surface soil conditions and slope position proved to be important gauges of productivity for all five species. Thickness and organic matter content of the  $A_1$  horizon, thickness of the total A horizon, and percent sand in the  $A_1$  horizon were correlated with yellow-poplar height growth. Percent organic matter in the  $A_1$  horizon was negatively related to site index of oak and pine.

Other findings include a positive effect of increase in slope percent on site index of black and scarlet oak, a positive effect of increasing latitude on site index of yellow-poplar, and higher site index for all species when yellow-poplar is present in the overstory.

Southwestern Forest Expt. Sta., FS, USDA, Asheville, N.C.

The principles followed in developing the 2-index system for rating fire danger in the ponderosa pine type of the Southwest have been published. This is a discussion of how to calculate, record, interpret, and apply the two indexes, and how to sample fire weather.

The two indexes of this system are a drought index and a rate-of-spread index, which are calculated and interpreted separately.

The drought index is calculated from: (1) Precipitation for the preceding winter; (2) seasons of year; (3) fire-season precipitation; and (4) daily air temperatures. Calculations start in the spring. Thereafter, drought index accumulates from day to day during precipitation-free periods by amounts that depend upon precipitation for the preceding winter, season of year, and daily air temperature. The amount of daily accumulation is determined from 1 of 15 tables, 1 for each combination of 3 levels of preceding winter precipitation and 5 different seasons of year. Within each table, the rate of accumulation of drought index depends only upon daily air temperature.

Precipitation reduces drought index. The amount of reduction depends upon the amount of current precipitation, amount of precipitation for the preceding winter, and the level of drought index before the rain. Adjustments for any combination of existing drought index and nine levels of current precipitation are obtained from one of three tables; one for each of three levels of preceding winter's precipitation.

Rate-of-spread index is based upon a litter-moisture factor, daily air temperature, and daily wind velocity. Litter-moisture factor, in turn, is determined from precipitation, daily temperatures, and time since last rain.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

SILVICAL CHARACTERISTICS OF \*\* Southeastern Forest Expt. Sta., Sta. Paper \*\*\*

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Nelson, T. C.	Shagbark Hickory.	135, 11 pp. 1961.
Renshaw, J. F.	White Basswood.	136, 7 pp. 1961.
Nelson, T. C.	Pignut Hickory.	137, 10 pp. 1961.
Campbell, R. A.	Chestnut Oak.	138, 12 pp. 1961.
Bennett, F. A.	Southern Magnolia.	139, 9 pp. 1961.

These five silvical papers briefly summarize knowledge concerning the distribution, habitat conditions, life history, special features, and genetic factors of the designated tree species.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Anderson, A. H. THE MULTIPLE-USE CONCEPT. Va. Wildlife 22(6): 4-5, 22. 1961.

Multiple-use land management may be referred to as a concept, a principle, or as a practice. Obviously, it is all three.

Multiple-use is a term familiar to foresters and other land managers. In terms of forests, we can consider four major uses--for wood production, use as watersheds, as habitat for wild game and fish, and use of the forest for outdoor recreation.

There are two basic elements of the multiple-use principle followed by the Forest Service. They are; (1) All resources receive equal consideration. No one resource or use automatically outranks another. And (2) there must be two or more major uses involved, and there must be coordination of these uses.

The Virginia national forests have four major renewable resources: timber, soil, water, and wildlife, and one nonrenewable, consisting of minerals.

Under this system of management it is seldom possible to obtain maximum production of any one resource because of the concessions that have to be made to accommodate the others. We feel that this kind of management will yield the greatest total benefits to the public from the uses of the resources. In planning and setting priorities, the intangible values which are difficult to assess and express in monetary terms are given equal consideration with those that produce financial returns.

George Washington Natl. Forest., Harrisonburg, Va.

Stone, R. N., and Thorne, H. W. WISCONSIN'S FOREST RESOURCES. Lake States Forest Expt. Sta., Sta. Paper 90, 52 pp. 1961.

A new inventory of Wisconsin's timber resources was completed in June of 1958. Since the first survey in 1936, the timber situation has improved in a number of important ways. The forests are better stocked, volume is higher, growth is greater, and allowable cut is larger. Competent forestry is being practiced on a larger part of the forest area, particularly on public and industry holdings. Statewide forest fire control has greatly reduced fire losses. Reforested area is accumulating. Considerable improvement has occurred in the overall size-class distribution although serious gaps and deficiencies in important types remain, especially in the conifer types. A great many stands that were young seedlings and saplings in 1936 have grown to poletimber and some are approaching sawtimber size. Sawtimber acreage is smaller but should expand as poletimber on large areas grows into sawtimber size.

Other aspects of the forest resources are unfavorable. Softwood acreage remains low. Conifers dominate the stands on less than 14 percent of the forest land of Wisconsin, about the same amount as in 1936. Although pine acreage has climbed somewhat, spruce-fir now occupies less area. The 1.2 million acres of nonstocked and poorly stocked land suitable for planting provides ample opportunity for increasing the supply of softwoods through reforestation.

The problem of excessive cull trees is Statewide. In Wisconsin, for every 11 merchantable trees, a cull tree of merchantable size occupies growing spaces, reduces net growth of the stands, and adds almost nothing to the timber harvest.

Sawtimber trees were smaller, on the average, in 1956 than in 1936, with somewhat less sugar maple and yellow birch.

The volume of timber lost through mortality each year nearly equals timber cut.

Wisconsin's forest lands are important not only for timber supplies but also for water, wildlife, and recreation. The statistics point to some of the problems that stand in the way of achieving full benefits from the forest resource.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Larson, R. W., Nichols, A. C., and Goforth, M. H. TIMBER TRENDS IN THE SOUTHEAST. Southeastern Forest Expt. Sta. Forest Survey Release 58, 16 pp. 1961.

Commercial forest area has been on the increase in the Southeast since the early thirties. During the past 20 years (1940-60), forest area has increased 4.5 million acres, or

about 5 percent. In 1960, forests covered 92 million acres, or 63 percent of the 147 million acres of land in the southeastern 5-state area.

Most of the increase in forest area took place before 1950; since 1950, forest area has increased only 1 percent, compared to 4 percent between 1940 and 1950.

In response to better fire protection, natural succession, and repeated cutting of pine from mixed pine-hardwood stands, hardwoods have been replacing pine on a large area in the Southeast for many years. During the past 20 years, the area of pine and oak-pine type dropped from 58 million acres in 1940 to 49 million acres in 1960. Over half this reduction took place during the past 10 years. The result is that the percentage of forest area in pine and oak-pine type was 53 percent in 1960 as compared to 66 percent in 1940.

Small pine sawtimber and large hardwood sawtimber increased between 1940 and 1950 but decreased since 1950.

In the future, landowners will have to depend more and more on planting to offset the prospective decline in natural pine regeneration. Currently, about 750 million pine seedlings are being distributed for planting annually in the southeast--enough to stock about a million acres. Some 4.5 million acres are cut annually. Recent surveys indicate that half or more of the cutover area is poorly stocked and will not restock naturally. The current planting program though greatly expanded during the past 10 years and an important step in the right direction, is still short of what is needed to restock the area cut annually. Much of the medium-stocked area is badly in need of stand improvement to release pine and better-quality hardwoods from cull trees and shrubs.

The outlook is for continued expansion of forest industries, an increasing cut from the same or less forest area, and the need to grow more and better-quality hardwoods and shrubs.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Nelson, T. C., Clutter, J. L., and Chaiken, L. E. YIELD OF VIRGINIA PINE. Southeastern Forest Expt. Sta., Sta. Paper. 124, 11 pp. 1961.

Virginia pine (Pinus virginiana Mill.) is the dominant species on many forest lands in Maryland, Virginia, and the Carolinas. Not many years ago Virginia pine was classed as a forest weed and commonly called "scrub pine". In recent years, the good pulping qualities of its wood, its heavy yields per acre, and its acceptance as sawtimber have led to increasing interest in the productive capacity of Virginia pine by landowners.

This paper reports cubic-yield estimates of Virginia pine stands of various densities, growing on different sites, and with varying proportions of the forest stand in Virginia pine.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Bernsten, C. M. GROWTH AND DEVELOPMENT OF RED ALDER COMPARED WITH CONIFERS IN 30-YEAR-OLD STANDS. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 38, 20 pp. 1961.

Early interest in the management of red alder in the coastal forests of Oregon and Washington stimulated the start, in 1935, of a long-term stand-growth and development study. Two 1-acre plots and two half-acre plots were established on abandoned cleared land where 8- to 12-year-old stands of red alder and conifers were developing. The conifer component consisted of a mixture of Douglas-fir, Sitka spruce, and western hemlock. Selections and treatments brought about diversified composition of the experimental stands, as

follows: (1) Pure alder, unthinned; (2) mixed alder-conifer, unthinned; (3) pure alder, thinned from an alder-conifer stand at age 11 years, and (4) pure conifer, thinned from an alder-conifer stand at age 8.

Beginning in 1941, 5-year periodic measurements were made through the 1956 growing season to provide data for comparing growth between treatments and species. Major results were: (1) By age 29 years, the slow-starting pure conifer stand had about equalled the volume of the 32-year-old unthinned pure alder and unthinned alder-conifer stands. (2) Yield of the thinned pure alder stand at age 31 was about 13 percent less than that of the unthinned pure alder stand. And, (3) yield of the unthinned alder-conifer stand at age 29 was the lowest of all experimental stands.

Results show that the conifer stand responded to release. In contrast, individual trees of the thinned pure alder stand showed negligible accelerated growth. This is interpreted to mean that the suppressed and perhaps intermediate trees in a pure, unthinned alder stand have only a thinning in the alder-conifer stand, however, resulted in a prolonged struggle between species and a reduction in yield.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Tarrant, R. F. STAND DEVELOPMENT AND SOIL FERTILITY IN A DOUGLAS-FIR--RED ALDER PLANTATION. *Forest Sci.* 7: 239-245. 1961.

A study was made of a 27-year-old mixed Douglas-fir and red alder plantation on the Wind River Experimental Forest in southwestern Washington. This plantation differs from natural mixtures of fir and alder commonly found in the Douglas-fir region in that genetic unsuitability of the alder planting stock has led to periodic cold damage, which has curtailed its growth. The Douglas-fir was able to compete more strongly than it could in a natural mixture, where red alder usually dominates the site during early years of growth.

Major findings of the study were:

1. Although there were more Douglas-fir stems in the pure plantation, there yet remained in the mixed stand an adequate average of 443 stems per acre. Also, there were 627 alder stems of about the same average diameter and height as the firs. More than twice the cubic volume of wood was produced in the mixed stand, with no adverse effect on average size of trees.
2. Dominant firs in the mixed stand showed significantly greater average diameter growth than those in the pure stand for the age periods 20-25 and 25-27 years. Measurements between ages 25 and 27 years indicated that these same dominants were also growing in height at a faster rate than those in the pure stand.
3. Form class of fir grown with alder was higher than that of fir grown alone. Limb measurements indicated a generally broader, more vigorous upper crown in the fir grown alone.
4. Total nitrogen content, both of the soil and of Douglas-fir foliage, was significantly greater in the plantation having alder mixture.
5. Numbers of soil bacteria and actinomycetes, and their ratio did not differ significantly between the two conditions sampled. Fungi were more numerous in soil beneath the pure fir stand.

Admixture of red alder in this Douglas-fir plantation evidently has contributed to increased growth of dominant firs, beginning at about age 20 years. This attests further to the reputed soil-improving quality of red alder through symbiotic fixation of nitrogen in root nodules.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

If thinning is started early in the life of the stand, the ratio of cost to revenues will be the greatest. For a \$5- to \$30-per-acre thinning cost, harvest value yield can be increased \$100 to \$175 per acre on poor sites, \$200 to \$600 on medium sites, and \$500 to more than \$1,000 per acre on good sites. In addition, there should be some opportunity for profit in intermediate cuts. Thinning in stands that have suffered from overcrowding would return less.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Tackle, D., and Shearer, R. C. STRIP-THINNING BY BULLDOZER IN A YOUNG LODGEPOLE PINE STAND. Proc. Mont. Acad. Sci. 19: 142-148. 1959.

How can precommercial thinning of lodgepole pine (*Pinus contorta*) be made to produce future wood values? Thousands of acres now are nonproductive because of excessive overstocking. The problem of developing economically feasible thinning methods to overcome depressed growth rates in these stands is pressing. Mechanization may be the answer.

There are two forms of mechanized thinning. In one, specially designed power operated equipment speeds up the cutting of selected individual trees. In the other, wholesale numbers of trees are destroyed by power equipment in a predetermined pattern without selection of individual stems.

Results of strip-thinning by bulldozer in a 30-year-old, even-aged lodgepole pine stand in western Montana offer an opportunity for assessing equipment and operator effectiveness and for comparing the relative growth in diameter, basal area, and height of trees in the reserve strips were summarized as follows:

1. The dozer blade cut or uprooted trees without excessive ripping of the soil surface. Trees 10 to 20 feet tall and about 3 inches d.b.h. were pushed over more readily than smaller, more limber trees.
2. Less difficulty was encountered by the tractor operator in leaving 6-foot-wide reserve strips than either 2-foot or 12-foot-wide strips. Six-foot strips were straighter and had more uniform width than either of the other two sizes.
3. Dominant and codominant trees showed greater response to release than intermediate and suppressed trees; however, relative to their respective unthinned controls, intermediate and suppressed trees grew faster than dominants and codominants.
4. Diameter, basal area, and height increment varied according to the distance of the trees from the edge of the reserve strip. Diameter and basal area growth was greatest near the edge and decreased toward the center; height growth showed a reverse trend.
5. Diameter growth responses in this strip-thinning were of nearly the same magnitude as those reported from selective thinnings in lodgepole pine in Colorado and Oregon.
6. Depression of height growth with increased release toward the strip edge is not unusual, but it is contrary to results from most selective thinnings within practical thinning grades. A parallel condition has been observed in natural thickets and clumps and in both thinned and unthinned plantations.
7. Strip-thinning with a bulldozer not only appears to be beneficial to tree growth, but it should greatly improve accessibility to overstocked stands and reduce the cost of future stand improvement work.

Intermountain Forest and Range Expt. Sta., FS, USDA, Missoula, Mont.

Foiles, M. W. EFFECTS OF THINNING SEED SPOTS ON GROWTH OF THREE CONIFERS IN THE INLAND EMPIRE. *J. Forestry* 59: 501-503. 1961.

Direct sowing of ponderosa pine, western white pine, and Engelmann spruce seeds in small prepared spots resulted in establishment of several seedlings in each spot. Some spots were artificially thinned to test the effects of seed-spot density on the growth of each of these species in northern Idaho and northeastern Washington.

Results of this experiment show that the number of seedlings per spot significantly affected diameter growth of 17-year-old trees of all three species. Diameter growth of the dominant seedlings decreased as the number of seedlings per spot increased. Height growth of ponderosa pine also decreased significantly with increasing seed-spot density. A decrease in height growth of western white pine on densely stocked spots was significant in one test but not in the other. Height growth of Engelmann spruce tended to decrease with increasing density, but not significantly.

Thinning seed spots is not recommended, for a satisfactory stand will develop without it. Thinning to increase diameter growth is advisable only under the same management and economic conditions that would make it advisable to thin dense natural stands.

Intermountain Forest and Range Expt. Sta., FS, USDA, Boise, Idaho.

Franklin, J. F. A GUIDE TO SEEDLING IDENTIFICATION FOR 25 CONIFERS OF THE PACIFIC NORTHWEST. *Pacific Northwest Forest and Range Expt. Sta. (unnumbered)* 65 pp. 1961.

Positive field identification of very young seedlings of Pacific Northwest conifers has been difficult because they often occur in mixture and available descriptions of seedling characteristics are scattered, incomplete, and in some cases, inaccurate.

This is a guide for the identification of young seedlings. It consists of a key to the seedling characteristics of 25 important conifers of the Pacific Northwest. Supplemental descriptions and photos are also provided for each. The key and descriptions are based on the characteristics of very young seedlings--that is, from the time seedcoats are initially shed until either (1) cotyledons are shed, or (2) the second season of growth starts.

Pacific Northwest Forest and Range Expt. Sta., FA, USDA, Portland, Oreg.

Clark, F. B. and Phares, R. E. GRADED STOCK MEANS GREATER YIELDS FOR SHORT-LEAF PINE. *Central State Forest Expt. Sta. Tech. Paper* 181, 5 pp. 1961.

Twenty-year research results show that, when planting shortleaf pine (*Pinus echinata* Mill.) on the poor sites in the Central States, it pays to use sturdy stock. For better survival and higher timber yields, 1-0 shortleaf pine planting stock should be at least 6 inches tall with a stem caliper of 3/20 inch or more 1 inch above the root collar. Greater yields can likely afford a premium price for high-quality stock.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Phares, R. E. and Liming, F. G. SHORTLEAF PINE DIRECT-SEEDING SUCCESS AFFECTED BY MONTH OF SEEDING, RELEASE METHOD, AND WEATHER. *J. Forestry* 59: 804-807. 1961.

Research in direct seeding shortleaf pine in the Missouri Ozarks shows that better success was obtained where seeding immediately followed removal of overstory trees by girdling rather than cutting or by girdling 1 year before seeding. Seeding in December

resulted in the establishment of more trees than seeding in February or March. Although seeding success varied greatly by years, release by girdling immediately followed by December seeding gave the best consistent results. Good stocking of seedlings in the first year assured the success of the seeding and also favored height growth of the seeded trees.

Central State Forest Expt. Sta., FS, USDA, Columbia, Mo.

Tackle, D. TEN-YEAR RESULTS OF SPOT SEEDING AND PLANTING LODGEPOLE PINE.  
Intermountain Forest and Range Expt. Sta. Res. Note 83, 6 pp. 1961.

Survival and growth of lodgepole pine seedlings in a 10-year-old plantation in central Montana established by spot-seeding at a 6- by 8-foot spacing were analyzed. Results of spot-seeding were compared with results from hand planting 1-1 nursery stock. The work was summarized as follows: (1) Seedspots formerly covered by conical wire screens were 69 percent stocked compared with 58 percent stocking of unscreened seed-spots. Mortality on both types of spots was low after the fifth year. (2) The number of seedlings per stocked spot was 2.8 and 2.2 for screened and unscreened seedspots, respectively. (3) Both the distribution and number of stocked spots per acre were adequate after 10 years. (4) Dominant seedlings in unscreened seedspots were significantly taller and larger in diameter than dominants in screened seedspots. (5) Number of seedlings per stocked spot (within a range of one to eight) did not affect either height or diameter growth. Therefore thinning of seed-spots is not recommended. (6) Survival of 1-1 nursery stock was 96 percent. And (7) mean height of transplants was 5.0 feet, or about 1-1/2 feet more than the average height of dominants on unscreened seedspots.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Stoeckler, J. H., and Skilling, D. D. DIRECT SEEDING AND PLANTING OF BALSAM FIR IN NORTHERN WISCONSIN. Lake State Forest Expt. Sta. Paper 72, 22 pp. 1959.

The results of a number of direct seedings and plantings of balsam fir are reported. Comparisons are made in a number of instances with planted white spruce. The results were summarized by the authors as follows:

1. Direct seeding was reasonably successful on: (1) Subirrigated sandy loam soils on the edge of peat swamps with ground prepared by scalping; and (2) in sapling and pole-sized aspen in the range of 2 to 6 inches in diameter where the ground was disked in strips and the protective overstory amounted to around 15 to 20 square feet of basal area.
2. Direct seedings of balsam gave poor results in: (1) Small openings in second-growth hardwoods prepared by scalping; (2) cross-disked, open, sodded land with only about 5 square feet or less of basal area of residual overstory aspen per acre; and (3) furrows in poorly stocked saplings of northern hardwoods.
3. Direct seedings of balsam fir were a failure in: (1) Open, sodded, disked, former hardwood land; (2) sphagnum moss on the edge of a peat swamp; (3) furrowed land in open sod; and (4) cross-disked, thinly stocked, sodded, second-growth northern hardwoods.
4. Screened spots invariably gave a much higher tree percent and percent of stocked spots than unscreened spots.
5. Shade of aspen or hardwood from an overstory of 15 to 40 square feet of basal area per acre increased survival of direct seeded balsam fir, but resulted in poorer height growth.

6. Disking, as a means of ground preparation, gave distinctly better stands in direct seeding than did furrowing.
7. The advantage of careful covering of the seed by hand was not clear-cut in terms of ultimate stand and stocking attained. The considerable increase in cost makes it doubtful whether it is worth covering the seed providing it can be dropped in favorable spots in newly prepared disked land. Brush dragging as a means of seed covering was poorer than no covering.
8. The use of cover crops to protect tender balsam seedlings from temperature extremes was unsatisfactory.
9. The results indicate that prospects of success with direct seeding of balsam fir are rather poor.
10. Plantings of 2-2 and 4-0 balsam fir were all successful, often through the 11th year. However, white spruce planted on comparable sites showed an advantage in survival over the balsam fir and greater height at the end of the 11th year. Height growth of balsam fir was reduced due to severe browsing by white-tailed deer.
11. Balsam fir seems to offer limited possibilities for reforestation by planting. Spruce will grow on practically any site adapted to balsam fir, and virtually all forest managers and industries would prefer the spruce over balsam.
12. The balsam fir planting and seeding results suggest the possibility of planting this species in 1- to 3-row parallel strips at intervals of about 100 feet in extensive areas of pure aspen or aspen-paper birch type growing on medium to good sites. This would establish rows of seed trees to aid in natural reseeding, gradually getting a partial conversion to conifers and increasing the overall softwood supply.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Shearer, R. C. WESTERN LARCH SEED DISPERSAL OVER CLEAR-CUT BLOCKS IN NORTHWESTERN MONTANA. Proc. Mont. Acad. Sci. 19: 130-134. 1959.

Data on dispersal of western larch seed through a 6-year experimental period were obtained from clear-cut areas on the Coram Experimental Forest were summarized as follows: (1) Two seed crops during the 6-year period were good, two were poor, and two were near-failures; (2) seed soundness as determined by cutting tests varied from 42.2 percent to 4.9 percent; (3) 92 percent of the total sound seed was dispersed by the good seed crops into the cut-over areas, 6 percent from the poor seed crops, and 2 percent from the near-failure crops; (4) seed dispersal declined rapidly from timber edge to 6 chains, then decreased slowly to the center of the 60-acre block; (5) virtually no seeds were dispersed past 4 chains from timber edge during poor seed years; (6) seed soundness declined with increased distance from the seed source; (7) most of the seed was dispersed uphill, probably by thermal slope winds occurring on hot, dry days; and (8) enough seed is disseminated throughout square, clear-cut blocks as large as 60 acres during an abundant seed year to provide adequate restocking.

Intermountain Forest & Range Expt. Sta., FS, USDA, Missoula, Mont.

Minckler, L. S., and Ryker, R. A. PARTIAL CONVERSION OF POOR HARDWOOD STANDS TO CONIFERS BY PLANTING. Central States Forest Expt. Sta., Tech. Paper 159, 9 pp. 1959.

Hardwood timber on poor upland sites in the Central States is commonly low in quality and yield. Natural shortleaf pine in Missouri and in the southern part of the Central States region generally produces more and better timber on dry, narrow ridgetops and upper south

slopes with shallow soil than do hardwoods. Red-cedar also grows well on such sites. Converting from pure hardwoods to a mixture of hardwoods and pine or cedar by planting is one promising way of increasing the production on these poor sites. Recent tests at the Kaskaskia Experimental Forest in southern Illinois show that successfully converting poor hardwood stands to mixed hardwood-conifers by planting depends chiefly on the size of openings planted, the quality of the site, and the amount, timing, frequency, and effectiveness of release done after the conifers are established.

For the areas studies, it is clear that the success of conversion plantings of shorleaf pine or redcedar depends upon: (1) The size of the overstory opening; and (2) the severity of competition from hardwood sprouts and saplings. A completely clear-cut area is best but pine and cedar will succeed moderately well, if the diameter of the opening is large enough. Where plantings in openings are made, however, the openings must usually be enlarged as the conifers grow larger.

To convert low-quality hardwood stands having no good growing stock trees to stands of conifers, all hardwood competition on the area should be killed before planting. When plantings are made for partial conversion, the good growing stock trees should be left and all others cut or killed. A deliberate attempt should be made to create openings 1-1/2 to 2 times the height of the overstory trees and no openings smaller than this should be planted.

In releasing conifers from hardwood brush (mostly oak and hickory) the kill must include both the tops and the roots. The release must be soon enough and frequent enough to allow continued vigorous growth of the planted trees. On the clear-cut area, the conifers were not released from competition until 6 years after planting. This was almost too late and the release was effective for only a short time because hardwood stems were merely cut with an ax. It is recommended that control of hardwoods in conversion plantings be done by poisoning.

The timing and intensity of release are important. When the intent is to fully convert to conifers, an attempt should be made to kill all the hardwoods before planting. If a mixed hardwood-conifer stand is desired, selective poisoning should be done and future release may be on a crop-tree basis. In this case the diameter of the released area (around the tree) should be at least twice the height of the competing hardwood stems being killed. Conifers should be released when the competing hardwoods begin to shade the upper half of the crowns of the crop trees.

Conversion of native hardwood stands to conifers or mixed conifer-hardwoods by planting will probably not be permanent. After one rotation of pine the native hardwoods will probably re-establish themselves unless steps are taken to retain the conifers in the stands. More likely, replanting accompanied by release will be required. Generally, in the Central Hardwood region, where conifers are not native, conversion planting should be confined to the poorest sites.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Church, T. W., Jr. SEASON OF LOGGING UNIMPORTANT IN CREATING DISTURBED SEEDBEDS FOR YELLOW BIRCH. Lake States Forest Expt. Sta. Tech. Note 605, 2 pp. 1961.

For effective seedling establishment, yellow birch requires a disturbed seedbed where mineral soil is present. It has often been suggested that sufficient seedbed scarification could be obtained by logging during the summer. The normal practice, however, is to harvest yellow birch and associated species during the winter when the ground is snow covered. But just how much scarification can be expected from logging selectively marked stands with different snow depths present?

The Lake States Forest Experiment Station began a study in Upper Michigan in 1957 to observe the effects of season of logging upon seedbed disturbance. The results were obvious: Summer logging provided greater scarification than did fall or winter logging. But the important point is that, except for skidways, disturbed seedbeds occurred on only 17 percent of the area even with no snow present. Furthermore, only 10 percent of the area was considered suitable for the establishment of yellow birch.

This study was established in an old-growth stand in the hemlock-yellow birch type. The principal species were eastern hemlock, yellow birch, sugar maple, and red maple. The site was flat and wet, which made logging more difficult during summer than winter.

It is evident that season of logging affects seedbed disturbance, but insufficient scarification is obtained from logging regardless of the season in which it is done. If our aim is to enhance the establishment of yellow birch, we should rely on specific treatments for seedbed disturbance rather than on logging. The slight increase in favorable seedbeds obtained by summer logging is not worth the extra troubles associated with logging moist sites at this season.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Sluder, E. R., Olson, D. F., Jr., and Jarrett, T. W. TESTS ON DIRECT SEEDING OF OAK IN THE PIEDMONT AND SOUTHERN APPALACHIANS OF NORTH CAROLINA. South-eastern Forest Expt. Sta., Sta. Paper 134, 12 pp. 1961.

Results of three tests of direct seeding of oaks, one in the Piedmont and two in the mountains of North Carolina, indicate that white, northern red, and black oaks can be successfully regenerated by direct seeding. Best results were obtained with acorns that were planted in mineral soil. Screen protection, though effective, proved to be unnecessary in the Piedmont study where all the acorns were planted in the soil, whether screens were used or not. Acorns used for direct seeding should be treated for weevil control and planted 1 to 2 inches deep in mineral soil. Planting may be done either in the fall or in the spring.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Miles, W. R. HAZARDS OF GROWING CHRISTMAS TREES. The Conserv. Volunteer. 24(144): 10-15. 1961.

There is a potential demand in Minnesota of about 1 million Christmas trees. About 6 million trees are produced a year, the bulk of which are balsam fir and black spruce. These species may always be the predominant Christmas trees but judging by the demand for trees in States to the east, the plantation-grown pines, especially the Scotch and Norway, will become more popular and in greater demand in the future in Minnesota.

In 1961, on plantations observed in the sandy, glacial area of east central Minnesota, approximately 42% of the Scotch pine and 60% of the Norway pine survived the first year.

Even after the trees are successfully established in the first year, there are enemies for the Christmas tree grower to combat. The most dangerous of these for its rapid and complete destruction of the plantation is FIRE! In addition to building and maintaining good fire lanes some safeguards can be taken to reduce the possibility of fire. Proper cultivating to reduce weed and grass growth in the plantation is a precaution. Pruning lower branches and the removal of these and the slashings left in the harvesting of trees is a further preventative. And the use of herbicides in building fire lanes and reducing inflammable grasses is suggested.

In a study conducted in 1960 and 1961, on 15 Norway and 7 Scotch pine plantations in east central counties in Minnesota, about 15% of the Norway and 13% of the Scotch pine trees were killed by gophers when no controls by poisoning or trapping were used. Added to average losses in the first year after planting, only 30 to 40% of the Scotch and 40 to 50% of the Norway pine might survive, if gopher controls were not used.

Three other major natural enemies of pine Christmas trees present themselves as risks to the grower; and these are insects, diseases, and genetic characteristics. Each of the following insects may crop up in epidemic proportions; all are present in endemic populations in our Minnesota pines at the present: pine shoot moths, Saratoga spittle-bug, pine weevils, pine tortoise scales, aphids, sawflies, grubs, and cutworms. They may become of major importance, if allowed to build up in any given area. There are specific controls which are effective. These include the use of soil fumigants: dieldrin, aldrin, heptachlor and chlordane, and sprays, such as lead arsenate and DDT.

Diseases have not been major hazards in the growing of Norway or Scotch pine in Minnesota.

Genetic characteristics of the pines present specific problems to the Christmas tree grower. Certain strains, particularly in Scotch pine, tend to become discolored, and unfortunately, this shows up most during the winter months. Also, certain strains tend to produce double-forks or double-leaders. This may be remedied by the Christmas tree grower removing one of the forks at the time of shearing. Coloration cannot be remedied.

Faced with this multitude of natural risks, the Christmas tree grower who is attempting to provide attractive trees must also consider economic risks. First and foremost of these is competition from other growers. The need for quality in plantation-grown trees becomes yet another economic factor. Other economic risks include distance to markets, competition at specific markets, local demands as to species, form, quantity, and quality of trees, and, finally, the sale of artificial trees.

U. Minn., St. Paul, Minn.

Burton, G. W., and Hughes, R. H. EFFECTS OF BURNING AND 2,4,5-T ON GALLBERRY AND SAW-PALMETTO. *J. Forestry* 59: 497-500. 1961.

A 2 x 3 x 3 x 2 factorial experiment with two checks, designed to discover a more effective method for controlling gallberry and saw-palmetto, was begun in the spring of 1956. In this test, plots burned March 7, 1956, and not burned were sprayed on May 2, August 26, and November 20, 1956, with 2, 3, and 4 pounds of acid-equivalent 2,4,5-T per acre in two carriers-water and oil. The experiment was replicated twice.

Leaf injury to both species increased with increasing rates of 2,4,5-T and was greater when oil was used as a carrier. It was not well correlated with control of these species, however.

Rate of 2,4,5-T had no effect upon control of either species, indicating that 2 pounds per acre was adequate in this test.

The best control of both gallberry and saw-palmetto was obtained by burning March 7 and spraying August 26 with 2,4,5-T in water. This treatment killed 84 percent of the gallberry stems by count and reduced the foliage cover some 75 to 85 percent. It also reduced competition enough to permit a threefold increase in the yield of forage grasses by September 1958.

When 2,4,5-T was applied in November, oil was a much more effective carrier for the herbicide than water. When the herbicide was applied in May, oil and water were equally effective as carriers.

CRD, ARS, USDA, Tiffen, Ga.

Aerial application of herbicides shows promise as a method for controlling brush on extensive areas of forest land in southwestern Oregon. Before the sites can be forested, prescribed burning may be necessary to remove the impenetrable mass of dead brush from the ground. However, burning may stimulate germination of dormant brush seeds in the soil and result in a dense stand of brush seedlings which might endanger survival of conifer plantations. This study was designed to learn whether controlled brush burning stimulates germination of brush seeds in the manzanita-ceanothus-live oak chaparral of the Siskiyou Mountains.

Both sprayed and unsprayed brushfields were burned. Large numbers of brush seedlings were found in the burned area; relatively few in the unburned. Sampling at the first summer after burning showed that the burned areas contained an average of more than 10,000 new brush seedlings per acre. In contrast, only a few seedlings were found in a sprayed brushfield that was not burned and under untreated green brush in the vicinity.

Brush seedlings found on the burned areas were mostly mountain whitethorn ceanothus (87 percent) and greenleaf manzanita (12 percent).

Competition of brush developing from this source alone would probably endanger survival of conifer plantations established on burned brushfields in this brush association. However, where respraying is necessary to kill resprouting brush on the burned areas, the herbicides probably would also kill most of the brush seedlings.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Gratkowski, H. TOXICITY OF HERBICIDES ON THREE NORTHWESTERN CONIFERS.

Pacific Northwest Forest and Range Expt. Sta. Res. Paper 42, 24 pp. 1961.

Vigorous natural reproduction of Douglas-fir, sugar pine, and ponderosa pine in southwestern Oregon was sprayed with 1/2-pound aehg solutions of low volatile esters of 2,4,5-T during 1956. When treated, the trees averaged 4 to 8 feet in height. Treatments were applied during the period of active growth in midsummer and repeated in early autumn after height growth had ended and buds were set. The chemicals were applied in three different carriers: (1) Water, (2) water plus spreader-sticker; and (3) a 5-percent diesel oil emulsion. Extent of damage from these treatments was determined by examination in October 1957 and September 1958.

Early autumn foliage sprays of 2,4-D and 2,4,5-T were far less damaging than mid-summer sprays on all three conifers in southwestern Oregon. Both pines sustained severe damage and a high percentage of mortality from midsummer sprays. Douglas-fir appeared to be more resistant than ponderosa pine and sugar pine. The pines were injured more by 2,4-D than by 2,4,5-T, but Douglas-fir was moderately resistant to both herbicides. During both seasons, damage to the conifers was greatest when the herbicides were applied in a diesel oil emulsion.

Results indicate that chemical release of Douglas-fir reproduction from brush competition may be possible in southwestern Oregon. But successful chemical release of ponderosa pine and sugar pine reproduction without damaging the trees is questionable. Even on Douglas-fir, the herbicides should be avoided or minimized in summer spraying.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Preliminary portable mistblower tests with various insecticides for control of the white pine weevil were made in 1958 and 1959. Results indicated that the portable mistblower could be used successfully for weevil control and also that lindane and DDT were the most promising of the insecticide formulations tested.

Final tests were made in the spring of 1960. DDT was selected for use in the tests in preference to lindane because of its lower cost. The sprays were applied by portable mistblower to a 4-acre white pine plantation, heavily infested with white pine weevil. A 6-percent DDT water emulsion applied at the rate of 3 gallons per acre (1-1/2 pounds of DDT per acre) satisfactorily controlled the white pine weevil.

N.Y. State Museum and Sci. Serv., Albany, N.Y.

Haworth, F. G. DWARFMISTLETOE OF PONDEROSA PINE IN THE SOUTHWEST.  
U.S. Dept. Agr., Tech. B. 1246, 112 pp. 1961.

The dwarfmistletoe (Arceuthobium vaginatum f. cryptopodum) (Engelm.) Gill is the most important pathogen of ponderosa pine (Pinus ponderosa Laws.) in the Southwestern United States. About 36 percent of the commercial ponderosa pine acreage in Arizona and New Mexico is affected by this dwarfmistletoe. The disease causes mortality and growth reduction in infected trees, and it also lowers seed production and timber quality. Heavily infected trees are also more susceptible to attack by insects and other diseases.

A general description of the shoots, flowers, fruits, seeds, and endophytic system of the dwarfmistletoe is given along with a discussion of the pathological aspects of infection. The factors influencing the distribution of the parasite including stand type, stand history, and site factors are described.

Several biologic agents (fungi, insects, birds, and mammals) affect the parasite, but they do not appear to be important natural control agents. Presumably resistant trees have been found, but no tests of susceptibility have been carried out.

Chemical control of dwarfmistletoes is not yet feasible.

Pruning can be practiced to effectively reduce dwarfmistletoe if trees are only lightly infected and if infections do not occur in or near the trunk. Pruning guides developed from tests with infected branches are given.

Dwarfmistletoe can be reduced to an innocuous level by silvicultural control methods. The following procedures are recommended: (1) Removal of all infected overstory trees; (2) removal or pruning of all infected trees in the understory; and (3) followup operations in all size classes. Control in lightly and moderately infected stands can be accomplished with relatively minor modifications of current cutting practices. The only additional work needed is the treatment of infected parts of the understory. Control in severely diseased stands necessitates heavier cuts and intensive followup operations.

Information is presented on the results of the following six studies on this dwarfmistletoe:

1. Life history as determined by inoculations. The seeds germinate within 1 month after they are expelled. Insects and other agents destroyed many seeds, and only about 5 percent of the seeds planted resulted in infection. The more recent internodes are the most susceptible but some infection occurred on growth as old as 9 years. Over 90 percent of the infections first produced shoots during the third, fourth, and fifth years after the date of planting. Flowers were first produced in 5 years and the first mature fruits in 6 years from the date of planting. A 1:1 sex ratio exists for this species.

2. Seed flight. The average horizontal distance traveled by the seeds was 17.4 feet, with a maximum of 42.0 feet.
3. Seed dispersal period. The bulk of the seeds were expelled during the 3-week period including the last week in July and the first 2 weeks in August.
4. Rate of spread. Infection in young stands progressed from an infected overstory at an average rate of 1.7 feet per year in stands where the crown canopy had not closed, and 1.2 feet annually in closed-canopied stands. The rate of lateral spread through even-aged stands averaged 0.9 foot per year.
5. Effects of growth rate of the host. There was a significant reduction in recent (last 5 years) radial increment only in trees in which at least two-thirds of the crown was infected. Recent radial increment in heavily infected trees was reduced 35 percent in 55-year-old stands and 52 percent in 140-year-old stands. There was a marked reduction in vigor of heavily infected trees of both age classes. The effect of dwarfmistletoe in heavily infected trees was most pronounced on recent radial increment and total volume, intermediate on height, and least on total diameter.
6. Witches'-broom formation. Three types of witches'-brooms associated with this parasite on ponderosa pine are described. The characteristics and relative abundance of the three types and possible explanations of how they are formed, are discussed. Systemic dwarfmistletoe infections are shown to arise from dormant pine buds that are stimulated by the parasite.

FS, USDA, Inform. Div., Washington 25, D.C.

Dixon, J. C., and Osgood, E. A. SOUTHERN PINE BEETLE: A REVIEW OF PRESENT KNOWLEDGE. Southeastern Forest Expt. Sta., Sta. Paper 128, 34 pp. 1961.

The southern pine beetle (Dendroctonus frontalis Zimm.) is one of the most destructive insects of pine in the South. Outbreaks of this native insect have occurred at irregular intervals since the 1890's. Estimates of losses from individual outbreaks range from 1,200 MBF to 200,000 MBF. In an outbreak in the Southeast from 1952-1955 an estimated 53,200 MBF of sawtimber plus 138,600 cords of poletimber were lost. Blue stain introduced by the beetle degrades the wood and causes additional economic losses even when dead trees can be salvaged. The dead pines which cannot be salvaged create a fire hazard and are usually replaced by slow growing, undesirable hardwoods. In most cases, stands become less productive and decline in commercial value.

Although this insect has been studied rather intensively and its general life history is known, its behavior and relationship to the environment and the factors contributing to epidemics are poorly understood. Outbreaks frequently occur without apparent warning, yet populations may disappear as quickly as they appeared. Research is needed to determine the factors contributing to the rise and decline of populations. The present review attempts to bring together pertinent data as an aid to future research.

Efficient chemical control methods have been worked out for the southern pine beetle, but such methods are only temporary remedies. They are stopgap measures and do not get at the basic problem.

The problem is to develop resistant trees and to regulate conditions so that the beetle populations are not able to reach outbreak proportions. Only through the development of satisfactory silvicultural controls can we eliminate costly temporary chemical control measures.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

The adult Saratoga spittlebug is about 1 cm. in length, smoothly contoured, and generally streamlined in appearance. Coloration varies from tan to brown with a silvery, irregular mottling over the wing covers. Adults first appear in late June and can be found throughout the summer until late September.

The egg, about 2 mm. in length with an elongated, teardrop shape, is glistening yellow to purple. Beginning in late July, eggs are deposited under the scales of red pine buds, generally in the upper part of the tree crown, where they remain over winter and hatch the following May.

Spittlebug nymphs undergo five instars before transforming into adults during late June. During the first four instars they have scarlet abdomens and shining black heads. Fifth-instar nymphs are tan to brownish, similar to the adult.

Saratoga spittlebug nymphs and adults do not feed upon the same host plant. Nymphal hosts are always low-growing herbs or shrubs (sweetfern, blackberry, hawkweed, etc.), whereas the adult host is a coniferous tree. Red pine and jack pine are the favored adult hosts in the Lake States.

The nymphs feed by inserting their mouth parts into the stem of the alternate host near the root collar. They are generally concealed beneath a thin layer of ground litter. When feeding, they withdraw plant juice and eject a white frothy liquid--thus forming the characteristic spittle mass around themselves. From one to many individuals may be found within a single spittle mass.

Adults feed by inserting their mouth parts into the cortical part of yew pine twigs, mostly on the 2-year-old internodes.

The Saratoga spittlebug may occur epidemically throughout the northern tier of States in the United States and in adjacent parts of Canada, where host conditions are suitable. Suitable conditions mainly include the presence of red pine or jack pine trees between 2 and 15 feet in height and sufficient quantities of alternate hosts.

Silvicultural control of the spittlebug is largely a matter of preventing the development of ideal alternate host conditions. This can best be achieved during the establishment of a plantation by avoiding areas that are completely offsite for red pine. The more rapid and vigorous the tree growth, the more unlikely that suitable alternate host conditions will persist for an extended period. The use of herbicides to control the alternate hosts has not proved to be biologically and economically effective.

Insecticide control of the adults, using aerial applications of 1 gallon of formulation containing 1 pound of DDT per acre, has given consistently good results on over 100,000 acres of plantations in the Lake States. Generally, one application will control the spittlebug for at least 3 years. Seldom are more than one or two applications needed to protect the trees until they grow out of the spittlebug-susceptible height range. Timing of the control operation is critical because: (1) The adults must be killed before eggs are deposited; and (2) the spraying must be delayed until adult transformation is at least 80-percent completed. This optimal time includes only about 15 days, usually in early July.

Control of the spittlebug on ornamental or roadside plantings can be achieved by removal of the alternate hosts or by ground application of insecticides.

From an economic standpoint, red pine and jack pine are the only tree species that suffer spittlebug damage.

The gross effects of heavy feeding--mortality progressing from smaller twigs to whole branches, eventually resulting in the death of the whole tree--are caused by a combination of at least three factors: (1) Mechanical injury to stylet-pierced cells; (2) dehydration caused by withdrawal of sap; and (3) blockage of conducting tissue caused by an accumulation of old, resin-filled feeding scars.

Because gross tree-damage symptoms do not become apparent before irreparable harm has been done, infestation appraisal techniques have had to be based on population surveys.

A survey of the late-instar nymphal population is the most satisfactory appraisal technique.

FS, USDA, Inform. Div., Washington 25, D.C.

Zaremba, J. ECONOMICS OF SOUTHERN PINE FORESTRY: FACTORS INFLUENCING THE CONSUMPTION OF SOUTHERN PINE. *J. Farm Econ.* 43: 1317-1331. 1961.

The various factors affecting the consumption of lumber and pulpwood of southern pine roundwood are discussed.

Rising personal family income and population provide the main basis for optimism regarding future lumber markets. Rising price and changing consumer preference appear to have offset the favorable influence of income and population growth during the last few decades. Expansion of the lumber market hinges upon a substantial increase in expenditures for research and development to improve the quality of lumber and wood products and to lower production costs.

The position of southern pine lumber in general has deteriorated. Pine lumber has lost most of its foreign markets, and its domestic markets outside the South have been largely taken over by other species. In the future, rising population will affect the consumption of southern pine lumber to a smaller degree than for all lumber, while rising income will probably exert a greater than average influence. Rising labor costs will definitely continue to make the price position of pine lumber worse; while stumpage prices, productivity, and transportation costs will probably be neutral in their influences upon relative southern pine lumber prices. The weak market position of southern pine lumber is due in large part to below average manufacturing and merchandising practices. The key to the improvement in pine lumber lies in better manufacturing and distribution practices.

The rapidly growing market for southern pine pulpwood stands out in sharp contrast to the shrinking lumber market. Productivity and output of the pulp and paper industry has kept pace with the expansion of the economy. Rising income and population will give rise to a steady increase in requirements for pulpwood in the future. The increasing pine timber supply and the prospects for mechanical handling of southern pine pulpwood may lead to a further increase in southern pine's share of the pulpwood market. The use of wood residue is the principal factor retarding the growth in demand for southern pine roundwood for pulpwood.

Fordham U., New York, N.Y.

### Windbreaks

Dawson, D. H. MEDIUM PURPLE WILLOW FOR MUCKLAND WINDBREAKS. *J. Soil and Water Conserv.* 16: 286-287. 1961.

In 15 field plantings established between 1955 and 1959 on drained and undrained muck soils, medium purple willow has been evaluated and found to be a good secondary muckland windbreak material. Plants have developed into a windbreak 9 feet high and 7 feet wide. It has given better results than 11 other shrubby species when the secondary windbreaks were used with primary windbreaks. Propagation of the plant is by cuttings. No insect or disease problems have been noted.

SCS, USDA, St. Paul, Minn.

At Akron, Ohio, in 1957-59 the effect of windbreaks 45 to 50 years old were studied to obtain measurements of effects on crop yields, soil moisture, extension of roots, and soil fertility effects of windbreaks.

Root extensions by windbreak materials is an accepted hazard in semiarid regions. The total area of farmland occupied by windbreaks is very small. Observations in northeastern Colorado indicate that sapping has little effect on native and introduced grass plantings but does depress growth and yields of adjacent annual crops. It appears that broadleaf trees are more competitive in this respect than are conifers. Conifer plantings at Akron have shown little sapping effect until 10-15 years after establishment from seedlings. Broadleaf plantings in the area show serious sapping into crop land up to a distance of 50 feet within 5-8 years. Bush-type species apparently have a very minor effect on adjacent crops.

The Akron plantings showed a direct yield reduction in wheat and sorghum attributed to extraction of water and some nitrate nitrogen as far as windbreak planting roots extended into the field. The deleterious effects of windbreak root extension were gradually reduced as distance from the windbreak increased. Excavated roots were very shallow and indicated possible growth extension for water. The ratio of root length to tree height was more than 2.5:1 in the cases tested.

The ability to trap snow within and around a planting is helpful for the survival of shelterbelts and windbreaks in low rainfall areas.

SWCRD, ARS, USDA, Akron, Ohio.

Read, R. A. BIBLIOGRAPHY OF GREAT PLAINS FORESTRY. *Rocky Mountain Forest and Range Expt. Sta., Sta. Paper* 58, 153 pp. 1961.

In the past 5 years, increasing emphasis has again been placed upon action and research programs of tree planting and associated problems of windbreak protection and land use in the agriculture of the Great Plains.

It is desirable to take a fresh look at the background of literature on the subject and carefully review previous accomplishments. In this way we can profit from past experience and prevent repetition of mistakes. A critical evaluation of past work can also aid in pointing out the important problems to be considered in current and future research programs. The background in Great Plains tree planting consists of nearly 100 years of experience.

This Bibliography brings together the world's literature on the subject of windbreaks over the past 80 years.

An effort was made to include all pertinent literature on natural and planted stands of trees, and related windbreak problems in the Great Plains region of the United States and Canada. References on windbreak influences work in Europe and Asia, included as a separate part of the Bibliography, are restricted to afforestation, windbreak planting, and windbreak influences. An index to broad subject-matter groups is provided to facilitate use of the Bibliography.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

## Fruit and Nut Crops

Krezdorn, A. H., and Adriance, G. W. FIG GROWING IN THE SOUTH. U.S. Dept. Agr., Agr. Hbk. 196, 26 pp. 1961.

The principal points on fig growing in the South discussed are: Botany and classification; varieties; soils, temperature relations; establishment of the orchard; management of the orchard; fig pests and diseases; handling fresh fruit; and processing.

ARS, USDA, Inform. Div., Washington 25, D.C.

Batjer, L. P., and Thomson, B. J. EFFECT OF 1-NAPHTHYL N-METHYLCARBAMATE (SEVIN) ON THINNING APPLES. Proc. Amer. Soc. for Hort. Sci. 77: 1-8. 1961.

Experiments with 1-naphthyl N-methylcarbamate (Sevin), a new thinning agent for apples, were conducted in New South Wales, Australia, and the State of Washington.

1. Sevin proved to be an exceptionally consistent thinner for Delicious, Golden Delicious, Winesap, Jonathan, and Granny Smith. Results with this chemical were similar to others used (Eggetol, NAA, and NAD) but somewhat more consistent.
2. Results with Sevin suggest considerable latitude in timing. About the same degree of thinning was obtained with sprays applied between 2 and 4 weeks from full bloom. Sprays applied earlier or later in some instances failed to accomplish the desired thinning.
3. 1.5 pounds of 50% wettable Sevin per 100 gallons resulted in about the same degree of thinning as 3 pounds.
4. A high degree of seed abortion, in fruits that persisted, occurred when Sevin was applied to Delicious, but it had a negligible effect on the seed content of other varieties.
5. The reduced seed complement in Delicious did not affect fruit growth rate, maturity, or accelerate harvest drop.
6. Sevin and NAA resulted in a similar amount of bloom the following year. The greater floral initiation, as compared with that of the checks, was assumed to be an indirect effect due to thinning.

CRD, USDA, Wenatchee, Wash.

## Field Crops

McMurtry, J. E., Jr. TOBACCO PRODUCTION. U.S. Dept. Agr., Agr. Inform. B. 245, 58 pp. 1961.

The growing and harvesting of various types of tobacco are discussed along with the control of insects and diseases in this complete culture and care bulletin. Many illustrations are presented.

ARS, USDA, Inform. Div., Washington 25, D.C.

Tests in 1960 at Whiteville, N.C., show that peanuts grown in 21-inch rows outproduced and outsold peanuts grown in traditional 42-inch rows.

Peanuts spaced 5 inches apart in 42-inch rows produced 2,000 pounds per acre. They sold for 10.8 cents per pound. Peanuts in 21-inch rows yielded 3,010 pounds per acre and sold for 11.13 cents.

The price increase was due largely to a higher percentage of extra large kernels. Percent of fancy-size peanuts also increased.

Cash returns from narrow-row peanuts were \$334 an acre. Wide-row peanuts returned \$216 an acre.

Narrow rows for peanuts have these advantages: (1) Increased yields and more returns per acre, and (2) easier weed control. This is because the plants shade the ground quicker. Cultivation, therefore, can be stopped sooner.

These advantages enter the narrow row picture: (1) Equipment must be set up to cultivate the narrow rows; (2) more seed is needed; and (3) peanuts are harder to harvest.

Narrow rows require the same attention as wide rows. So if equipment is not available to cultivate and dig narrow rows, then no advantage is obtained.

Agr. Expt. Sta., N.C. State Col., Raleigh, N.C.

Pierce, W. H., and Mills, W. T. AN EVALUATION OF A MECHANIZED SYSTEM OF PEANUT PRODUCTION IN NORTH CAROLINA. N.C. Agr. Expt. Sta. B. 413, 27 pp. 1961.

An economic and technical evaluation from detailed records of inputs and outputs of a mechanized peanut production system was studied. The practices used were those recommended by North Carolina Agricultural Experiment Station from the standpoint of fertilization, variety, rate of seeding, and other practices.

The specific objectives included a determination of: (1) Labor and equipment inputs required for all operations in a mechanized peanut production process; (2) the average seasonal distribution of labor requirements when mechanized production practices are used; and (3) the cost and returns in the production of peanuts when recommended production practices are used under the technical environmental conditions expected to exist in a commercial area of production. The work was summarized as follows:

1. Peanuts are a perishable crop as they require special attention during the production process and proper drying conditions for maximum quality of peanuts and hay when harvested.
2. Peanuts are a profitable crop when produced according to recommended practices. The net cash return per hour of labor averaged about \$3.80 (does not include a charge for land, capital, management and other overhead costs).
3. In some areas, tobacco, cotton, and peanuts are companion enterprises in the farming systems used by farmers. Acreage allotments are involved in the amount of land planted in each crop. This situation influences the type of rotation which can be followed and the type of soil treatment required for efficient production of all crops included in the rotation system.
4. Further reductions in labor requirements are necessary to reduce the average cost of production. Part of this reduction may be achieved by the development of an effective method of chemical weed control and effective use of the "once-over" method of harvesting.

5. The larger savings in labor per acre have been obtained from the use of the windrow method of harvesting since necessary mechanical equipment for other operations is available on most commercial peanut farms.
6. The windrow method of harvesting appears to be technically and economically practical, especially if drying facilities are available on the farm.
7. If a producer has 26 or more acres of peanuts, ownership of windrow harvesting equipment is economically practical.
8. If a producer has fewer acres than the "break-even point," approximately 26, there is an alternative of having his crop harvested on a custom basis or doing custom work with his own windrow equipment.

Agr. Expt. Sta., N.C. State Col., Raleigh, N.C.

Cook, F. T., Jr., and Heagler, A. M. FACTORS AFFECTING SOYBEAN YIELDS IN THE DELTA. Miss. Agr. Expt. Sta. B. 630, 8 pp. 1961.

Research at the Delta Branch Experiment Station (Hartwig 1954) has shown that May 10 is the optimum average date for planting soybeans, if good yields are to be made. This study indicates that this planting date results in higher yields under farm conditions.

The use of rotations is also important in producing high yields of soybeans. The principal effect of rotations is that of weed control. Soybeans that follow cotton, rice, or fallowed land have fewer weeds than those following soybeans or corn.

The use of recommended soybean varieties is associated with the high yields. A farmer who plants a good variety of soybeans at the wrong time and does not control weeds is likely to get low yields.

Use of one good practice alone will not insure high yields of soybeans. Combination of all practices used to produce soybeans determine yields in any one year. Weather permitting, good yields of soybeans result when good varieties are planted at the correct time and weed control is effective.

Some production costs were virtually the same for the three yield groups, farmers who obtain the higher yields had higher net returns. A substantial increase in returns can be achieved with improved practices and management in soybean production.

ERS, USDA, and Miss State U., Agr. Expt. Sta., State College, Miss.

Casselman, T. W., Schmidt, J. L., and Lovely, W. G. CORN TOPPING PRIOR TO HARVEST. Agr. Engin. 42: 542-545. 1961.

Results of corn topping experiments conducted in Iowa in 1958 and 1959 show that topping had little or no effect on the rate of field drying regardless of the topping date. The only exception was in the 1959 early planted corn where the rate of decline of kernel moisture content of the corn topped 10 days after pollination was significantly faster than the rate of decline of the untopped corn. Differences in test weights and shelling percentages between topped and untopped corn were not significant; however, the weights and percentages averaged slightly lower in the topped corn. Though total yields were not significantly different, there was a tendency toward lower yields in the topped corn, especially in corn topped very early in the season (i.e., 10 days after pollination).

Stands, lodging preharvest losses, machine losses, and machine yields did not show any significant differences due to topping.

Observations of field-scale operations indicate topping improves the comfort and visibility of the picking machine operator.

Everglade Br., Fla. Agr. Expt. Sta., Belle Glade, Fla.

Brooks, S. N., Horner, C. E., and Likens, S. T. HOP PRODUCTION. U.S. Dept. Agr., Agr. Inform. B. 240, 46 pp. 1961.

Hop production in the United States is discussed including such subjects as: Description; climate and soils; varieties; establishment; culture; diseases and insects; harvesting; drying; curing; baling and storing; quality; production and marketing; and cost of production.

ARS, USDA, Inform. Div., Washington 25, D.C.

Stokes, I. E., Coleman, O. H., Freeman, K. C., and Broadhead, D. M. CULTURE OF SUGAR-CANE FOR SIRUP PRODUCTION. U.S. Dept. Agr., Agr. Hbk. 209, 31 pp. 1961.

The primary objective in growing sugarcane for sirup is to obtain the largest possible yield of good-quality sirup. Yield and quality of sirup are affected by the variety, diseases, insects, fertilizer and cultural practices, harvesting, and manufacturing processes. These subjects are discussed in this culture and care handbook.

ARS, USDA, Inform. Div., Washington 25, D.C.

Peters, E. J., Davis, F. S., Klingman, D. L., and Larson, R. E. INTERRELATIONS OF CULTIVATIONS, HERBICIDES, AND METHODS OF APPLICATION FOR WEED CONTROL IN SOYBEANS. Weeds 9: 639-645. 1961.

Pre-emergence treatments of sodium pentachlorophenate (PCP) resulted in less weeds and greater yield of soybeans than treatments with CDAA or the check. Plots sprayed overall produced more soybeans than those having band treatments because of better weed control. Cultivations alone gave poorer weed control and lower yields than combinations of herbicide treatments and cultivations.

Two cultivations significantly increased yields of soybeans and gave better weed control than 1 cultivation where weeds were not well controlled by herbicides. Three cultivations were not significantly superior to two. Greater benefits were found from the two or more cultivations of the check plots (no herbicides) than in plots treated with herbicides. Where PCP was used overall and when it eliminated nearly all the weeds, there was no significant benefit from more than one cultivation.

CRD, ARS, USDA, Columbia, Mo.

Frans, R. E., and Hurst, H. R. HERBICIDE SCREENING TRIALS ON FIELD CROPS, 1960. Ark. Agr. Expt. Sta. Mimeo Series 100, 12 pp. 1961.

Four herbicide screening tests were conducted on field crops at the Main Experiment Station in Arkansas in 1960: separate pre- and post-emergence tests on cotton, a combined pre-and post-emergence test on soybeans, and a pre-emergence test on corn.

In the cotton pre-emergence test, none of the experimental compounds equaled the performance of the standards--diuron and CIPC. Dicryl, ipazine, and DP685 continue to show promise as post-emergence herbicides on cotton although specific rates for maximum weed control and minimum crop injury need further refinement.

In soybeans, amiben and CP17029 were particularly promising as pre-emergence treatments, and a combination of DNBP and amiben applied post-emergence appears worthy of

further consideration. Ipatone, 5996, G-34161, simetone, and atratone need further evaluation as pre-emergence treatments.

In corn, simazine, atrazine, and diuron were outstanding. The experimental herbicide CP17029 also was promising.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Ullstrup, A. J. CORN DISEASES IN THE UNITED STATES AND THEIR CONTROL. U.S. Dept. Agr., Agr. Hbk. 199, 29 pp. and color plates. 1961.

The corn (*Zea mays L.*) crop of the United States is subject to a number of diseases that reduce both yield and quality. Yearly losses range from about 2 to 7 percent, but in some localized areas one or more diseases may become acute and destroy a considerably higher proportion of the crop. Ear and kernel rots decrease yield, quality, and feeding value of the grain. Stalk diseases may not only lower yield and quality but also make harvesting difficult. When leaves are damaged by diseases, the production of carbohydrates to be stored in the grain is lessened, and immature, chaffy ears result.

The diseases of corn may be classified as parasitic and nonparasitic. Most of the parasitic or infectious diseases of corn are caused by fungi, a few by bacteria, and a few by viruses. Fortunately no known virus diseases of corn have been found in the Corn Belt of the United States. Some parasitic diseases are caused by nematodes. They have not become serious in the main corn-growing areas of this country, but they are prevalent in the Southern States.

Nonparasitic diseases result from unfavorable climatic and soil conditions. Deficiencies in the soil of nitrogen, phosphorus, or potassium cause some of the most frequently observed nonparasitic diseases of corn. Occasionally corn may suffer from the lack of essential minor elements in the soil.

The diseases of corn seldom become severe over very wide areas. The production of corn in any given locality of the United States has not been limited by disease where soil and weather conditions have been favorable for the crop, nor has it been necessary to stop growing the crop over a wide area because of disease.

Only the parasitic diseases caused by fungi, bacteria, and viruses are treated in detail. They are described and illustrated and methods of control are given.

ARS, USDA, Inform. Div., Washington 25, D.C.

Kerr, E. D., Poehlman, J. M., and Brown, H. E. METHOD OF PHORATE APPLICATION AND ITS EFFECT ON HESSIAN FLY CONTROL, GERMINATION, AND FORAGE AND GRAIN YIELDS OF WHEAT. Agron. J. 53: 300-303. 1961.

Phorate applied in a granular form effectively controlled a moderate infestation of the hessian fly. This was the only experiment in which fly was present.

Phorate applied as a seed treatment reduced stands and delayed maximum germination by 3 to 7 days. Smaller stand reductions followed application of phorate as a fertilizer additive. Stands following phorate applied in the form of 10% granules were not significantly different from stands in the untreated plots.

Forage yields of wheat following phorate seed treatments and phorate applied as a fertilizer additive were significantly lower than yields from untreated plots. This was due in large part to reduced stands. Phorate applied in granular form was followed by a significant increase in forage yields. Apparently much of the increase was due to something other

than control of the hessian fly. Largest forage yields were obtained with the earlier seeding dates, emphasizing the need for early seeding to obtain maximum fall forage.

Grain yields were significantly higher following phorate applied as a fertilizer additive but were decreased because of reduced stands following phorate applied as a seed treatment.

Phorate did not affect test weight or plant height.

J. Art. 2240, U. Mo., Columbia, Mo.

Stippler, H. H., and Castel, E. N. WHEAT FARMING IN THE COLUMBIA BASIN OF OREGON:

I. MAJOR CHARACTERISTICS OF AGRICULTURE. Oreg. Agr. Expt. Sta., Sta. B. 577, 23 pp. 1961.

A number of major characteristics of the Oregon wheat area that are important in subsequent analysis of costs and returns from wheat farming are discussed. The characteristics are useful for studying possible adjustments to changing economic conditions or program proposals to alleviate the wheat surplus situation.

Cash grain farming with or without range livestock remains the major type of agriculture in the wheat area. Barley production has become important only since initiation of the acreage allotment program, as an alternative crop on land diverted from wheat. The gradual increase in livestock production has been accomplished by better use of land resources not suited for grain crops rather than by diversion of land from wheat.

Wheat farms are generally large in size both in terms of acreage operated and volume of sales of farm products. Combination wheat-livestock farms on the average are largest in overall size but have less cropland per farm than specialized wheat farms with unimportant livestock enterprises. The latter include nearly three-fourths of the total cropland available in the wheat area.

Full ownership over the area as a whole is most common on specialized wheat farms, particularly on small and medium-size ones. Part-ownership increases rapidly as the size of operation increases, especially on wheat farms having an important livestock enterprise. The number of tenants is significant only on specialized wheat farms without major livestock enterprises. It is largest on medium-size farms and decreases as the size of operation increases.

Most wheat farms operate on an alternate crop-fallow basis. Only in the higher rainfall belt is annual cropping with wheat, peas, other grains, and a few forage crops possible. The cropland so used is less than 10% of the total cultivated land. Fall seeding of grains is generally preferred because it results in higher yields, lower erosion damage during the winter, and lower costs. Spring seeding is necessary in case of adverse weather in the fall or excessive frost damage, experienced mainly in barley production.

New technology in farming, mainly improved practices, weed control, fertilization, and better varieties have contributed greatly to rapidly rising yields.

The level of yields on specialized wheat farms is somewhat higher than on wheat farms with significant livestock enterprises. Differences, however, are caused by the location of farms and the productivity of existing land resources rather than the type or size of operation.

Oreg. State U., Agr. Expt. Sta., Corvallis, Oreg.

Stippler, H. H., and Castle, E. N. WHEAT FARMING IN THE COLUMBIA BASIN OF OREGON:

II: COSTS AND RETURNS ON SPECIALIZED WHEAT-SUMMERFALLOW FARMS. Oreg. Agr. Expt. Sta., Sta. B. 578, 22 pp. 1961.

Income and expense data are presented for specialized wheat-fallow farms with respect to: (1) Tillage practices; (2) farms sizes; (3) productivity levels; and (4) product prices. The study

was designed to help individual farmers in making farm business decisions, and policymakers in determining the effect of wheat programs on individual farms.

The technique of farm budgeting was used to organize the cost and return data.

Although budgets do not permit accurate estimates to be made of cost of production per bushel of wheat or barley, they can be used to make comparisons. Emphasis is placed on relative costs and returns rather than on the absolute level of these items. The farmer can use the comparisons in deciding among practices or in selecting the size of operation that best fits his resources and goals. By the same token, the person interested in policy can compare the effect of a particular program on the incomes from farms of different sizes, yields, and operating practices.

The budgets are of typical farming situations. A farmer may wish to prepare budgets for his own situation rather than to apply the results of this study directly. Farmers are encouraged to do this and to keep the kind of farm records that will furnish the basis for such an analysis. An appendix is included for use by the individual farmer.

Oreg. State U., Agr. Expt. Sta., Corvallis, Oreg.

### Vegetable Crops

Doolittle, S. P., Taylor, T. L., and Danielson, L. L. MUSKMELON CULTURE. U.S. Dept. Agr., Agr. Hbk. 216, 45 pp. 1961.

Climate and soil; crop rotation; varieties; seed supplies; soil preparation; methods of planting; care of growing plants; insect enemies and their control; diseases and their control; harvesting and handling; grading and packing; and local marketing are discussed in this culture and care handbook on muskmelon culture in the United States.

ARS, USDA, Inform. Div., Washington 25, D.C.

Bishop, J. C., and Schweers, V. H. SPOUT INHIBITION OF FALL-GROWN POTATOES BY AIRPLANE APPLICATIONS OF MALEIC HYDRAZIDE. Amer. Potato J. 38: 377-381. 1961.

In Tulare County, Calif., airplane application of maleic hydrazide as MH-30 on fall grown potatoes retarded sprouting in field storage and in subsequent common storage. Weight loss in common storage was significantly reduced. Total yield was not significantly affected. Three pounds of maleic hydrazide per acre were generally as effective as were 6 pounds.

There was a wide range in the amount of maleic hydrazide residue found in the tubers at harvest. On the average, about twice as much maleic hydrazide was found in the tubers from plants treated with 6 pounds of maleic hydrazide per acre than was found in those from the 3-pound plots.

Specific gravity of tubers harvested on February 26, 1959, and on March 23, 1960, was not affected by treatment.

Preliminary results in 1957-58 showed that hand-sprayed maleic hydrazide prevented a reduction in specific gravity of soil-stored potatoes when harvest was delayed.

U. Calif., Davis, Calif.

Carolus, R. L., and Brow, L. D. WE'VE BEEN OVERFEEDING ASPARAGUS. Amer. Veg. Grower. 9(3): 9, 52-53. 1961.

Because of the large quantity of roots developed by high producing asparagus, the crop requires a well granulated soil in a high state of tilth to facilitate adequate subterranean aeration.

Soil compaction and inadequate internal drainage are probably more responsible for low asparagus yields than inadequate fertilization. Large quantities of fertilizer have been wasted in attempts to increase the productivity of low yielding plantings, when the fundamental difficulty was due to poor aeration in the subsurface soil resulting from poor soil structure.

A careful preplanting soil building program, using deep rooted legumes and/or the incorporation of other types of organic matter for a few years prior to planting asparagus would do much to insure suitable aeration conditions.

Liming soils on which asparagus is to be grown to bring the pH value to 6.2 to 6.5 to a depth of 12 to 18 inches will promote soil particle aggregation and flocculation and result in improved aeration.

Setting the crowns in soil that has not been puddled or compacted will help the new plantings become better established the first season.

The application of manure will promote improved granulation and better internal soil aeration. These are highly desirable soil properties for the development of healthy, vigorous, fleshy roots.

Proper timing in diskng and dragging the asparagus field under the wet conditions of early spring will help maintain structure and prevent clod formation, thereby promoting desirable soil physical conditions for satisfactory root performance.

The building up and maintenance of a desirable soil structure in asparagus fields will pay large dividends in terms of longevity and productivity and is probably more important than fertilization to the mature planting.

#### NEW SUGGESTED FERTILIZER PRACTICES FOR ASPARAGUS

All application figures are in pounds per acre with low values suggested for soils testing "high" and high values suggested for soils testing "low."

N--nitrogen; P<sub>2</sub>O<sub>5</sub>-- phosphate; K<sub>2</sub>O--potash.

##### Year of Crown Planting:

20-40 N, 40-80 P<sub>2</sub>O<sub>5</sub>, 40-80 K<sub>2</sub>O (5-10-10, 10-20-20).

Broadcast and plow in before trenching for crown setting.

30-60 P<sub>2</sub>O<sub>5</sub> broadcast down the trench (20% superphosphate).

30 additional N at first cultivation (Ammonium nitrate).

Omit on soils built up with legumes or manured.

##### 2nd & 3rd Year Following Crown Setting:

###### For plant development--

25-50 N, 50-100 P<sub>2</sub>O<sub>5</sub>, 50-100 K<sub>2</sub>O

Broadcast and disk in during spring fitting of the field.

30 additional N after soil warms up.  
(Omit on soils that are being manured.)

##### 4th through 7th Year and Then Repeated: For maintenance and crop nutrient removal--

40-60 N each year after harvest is completed. Omit if manured.

5th year--60-120 K<sub>2</sub>O. Omit if soil tests high in K or is being manured.

7th year--30-60 P<sub>2</sub>O<sub>5</sub>, 30-60 K<sub>2</sub>O. None if soil test high in P and K.

If crop has been harvested by snapping, use the low values; if yields of cut grass are higher than 5500 pounds per acre, increase fertilizer proportionally.

If crop has been over-fertilized for a number of years, apply N alone until soil tests indicate a reduction in fertility levels.

Have soils tested to be sure of their nutrient status.

Mich. State U., East Lansing, Mich.

Walkof, C. AN IMPROVED METHOD OF TOMATO TRANSPLANT PRODUCTION FOR THE NORTHERN PLAINS. Proc. Amer. Soc. for Hort. Sci. 75: 579-583. 1960.

A method of tomato transplant production for short growing season areas in the Northern Plains Region designated the Morden System has been developed at the Canada Experimental Farm, Morden, Manitoba. It is useful in plant breeding and research studies, as well as commercial production, as larger plant populations can be produced without increasing plant growing facilities in comparison with the conventional method of transplant production.

In the Morden System the seedling are not transplanted, but remain in the confinement of the seeded box, approximately 10 per square inch, for 4 weeks. The soil in the box is 5 inches deep to support the plants.

In a 5-year test, total yields of tomatoes from three varieties were 51 percent greater with the Morden System than with the conventional method. In addition to increased yields the new method allowed approximately 40 times more transplants in standard greenhouse space.

Results of a detailed test in 1958 indicated that even greater yields may be expected from the Morden System if the seed is sown April 1 rather than April 15--the standard date. Moreover, the percentages of marketable tomatoes were greater from the early seeding.

The essential function of plant protectors in the Morden System was indicated in the 1958 test. Plants that were shielded from adverse environment produced high yields and excellent quality fruit. It is important also that the transplants used be small and immature when they are set in the field. Their growth and development was continuous and unchecked under the protectors.

Res. Br. Canada Dept. Agr., Expt. Farm., Morden, Manitoba, Canada.

Prashar, P. THE EFFECTS OF 2,4-D ON TOMATO PLANTS. S. Dak. Farm and Home Res. 12 (3): 24-25. 1961.

During the summer of 1960 a study was made at South Dakota State College showing the effect of 2,4-D on tomatoes. This study showed that a very light spray mist of 2,4-D can markedly reduce the quality and quantity of tomatoes. Three varieties--Sioux, Siouxann hybrid, and State Fair hybrid--were tested.

Tomatoes are very sensitive to 2,4-D. It doesn't have to be sprayed directly on the plants. The active ingredient of 2,4-D may be carried by air currents and cause injury at a distance of a mile or more from the sprayed area. The drift of 2,4-D fumes or spray depends upon the wind currents and other environmental factors. Sometimes this can do a lot of damage without the tomato grower knowing the cause.

Tomato plants in all stages of growth are susceptible to injury from 2,4-D. The degree of injury is directly proportional to the concentration of the chemical to which the plant is exposed. The symptoms may not become apparent until 5 to 10 days after spray exposure or until the new leaves have expanded. The entire plant may die within 7-10 days or the chemical may just delay fruiting. Generally, the upper part of the stem becomes twisted and the leaf petioles bend downward.

The early yields of tomatoes were tremendously reduced when plants were affected in early stages of fruit set. Plants that were staked suffered more from 2,4-D injury than those unstaked.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Doolittle, S. P., Taylor, A. L., and Danielson, L. L. TOMATO DISEASES AND THEIR CONTROL. U.S. Dept. Agr., Agr. Hbk. 203, 86 pp. 1961.

Tomato diseases are of two general types--parasitic and nonparasitic.

Parasitic diseases are those caused by living organisms, chiefly bacteria and fungi, and by viruses. The parasitic group includes most of the common and serious tomato diseases.

Nonparasitic diseases are caused by unfavorable environmental conditions, such as excessive moisture or drought, extremes of temperature, and lack or excess of certain mineral elements in the soil.

Bacteria and fungi are microscopic organisms that obtain their food from the plant they attack or from decaying organic matter in the soil. They enter the plant through wounds and natural openings or directly penetrate the epidermis. After entering the plant, they multiply within the plant tissues and produce specific symptoms, such as wilting of the plant, spotting or curling of the leaves, and decaying of the fruits.

The bacteria affecting tomatoes are one-celled, rod-shaped organisms that multiply with great rapidity in the plant. They occur on the surface of diseased plants either as exudates or as the result of a breaking open of the diseased tissue and, when so exposed, are readily spread to other plants by splashing rain, insects, or human beings.

The fungi are more complex organisms with threadlike vegetative growth (mycelia) from which are usually produced various types of structures that bear seedlike bodies known as spores. In the presence of moisture these spores can germinate and produce new infections. They are spread by wind, rain, drainage water, insects, and persons working among the plants.

Plant viruses are complex protein substances that increase rapidly in the plant. The individual virus elements are too small to be visible except under the electron microscope. Viruses are highly infectious, and many of them are readily transmitted by any means that serve to introduce a minute amount of juice from a virus-infected plant into a slight wound or abrasion in a healthy one.

The most common means of transmitting virus diseases are sucking insects, particularly aphids, and the brushing against, handling, or pruning first of diseased and then of healthy plants.

Ordinarily, a diseased plant cannot be cured; therefore, control must be based on the prevention of the disease and of its spread. When disease-free plants are set in clean soil, the likelihood of serious losses is greatly reduced.

This handbook describes and illustrates the diseases commonly affecting tomatoes in the field and greenhouse and gives measures recommended for reducing losses from them. As the methods of control vary with the nature and cause of the individual disease, it usually is necessary to determine what particular disease is responsible for an injury before applying control measures. An accurate diagnosis is necessary to prevent waste of time and materials. Often a careful examination of the leaves, stems, and roots is required to be sure that the disease is diagnosed correctly.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hofmaster, R. N., and Dunton, E. M., Jr. SOIL APPLICATION OF INSECTICIDES FOR THE CONTROL OF FOLIAGE PESTS OF IRISH POTATO. Amer. Potato J. 38: 341-345. 1961.

The effects of systemic granulars applied to Irish potatoes at planting were studied on 5 species of insects at Painter, Va.

Results in 1959 clearly indicated that both 2 and 3 pound per acre rates of Thimet gave excellent control of potato flea beetle (Epitrix cucumeris Harr.), potato leafhopper (Empoasca fabae Harr.), and potato aphid (Macrosiphum solanifolii Ashm.) throughout the season. The extent of European corn borer (Pyrausta nubilalis Hbn.) infestation was reduced approximately 75% at the 3 pound level but the 2 pound rate was comparatively ineffective.

Both Thimet and Disyston granulars at 2.5 pounds per acre gave striking control of heavy potato leafhopper infestations in 1960. They yielded more than 400 cwt. of potatoes per acre compared with the 300 cwt. per acre for the untreated check.

The systemic granules prevented newly hatched Colorado potato beetle larve (Leptinotarsa decemlineata Say) from completing their life cycle. These compounds were only partially effective against DDT-dieldrin resistant larvae.

Of special interest is the fact that the specific gravity of Pungo potatoes in the Thimet and Disyston plots was consistently higher than in the untreated check.

Va. Truck Expt. Sta., Eastern Shore Br., Painter, Va.

Gavett, E. E. TRUCK CROP PRODUCTION PRACTICES: ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA; LABOR, POWER, AND MATERIALS BY OPERATION. Econ. Res. Serv. ERS 45, 51 pp. 1961.

To gain further knowledge of some of the inputs involved in production of vegetables, information regarding the 1958-59 crop was obtained from 2,496 vegetable growers in 12 areas.

The areas included in the survey were selected on the basis of importance of seasonal and overall production, diversity of crops grown- both for fresh market and for processing- and number and proportion of farmers harvesting truck crops for sale.

This report presents information on labor requirements, production practices, and costs involved in the production of truck crops in Accomack and Northampton Counties, Va. It is the second in a series covering the 12 survey areas.

Numerous charts, tables, and maps.

ERS, USDA, Inform. Div., Washington 25, D.C.

Gavett, E. E. TRUCK CROP PRODUCTION PRACTICES COLUMBIA COUNTY, WISCONSIN: LABOR, POWER, AND MATERIALS BY OPERATION. U.S. Dept. Agr., Agr. Res. Serv., ARS 43-132, 16 pp. 1961.

To gain further knowledge of some of the inputs involved in production of vegetables, information regarding 1958-59 crop was obtained from 2,496 vegetable growers in 12 areas.

This is the first of a series of 12 publications containing information on labor requirements, production practices, and costs involved in the production of truck crops for fresh market and for processing. It presents information on production of sweet corn and green peas for processing, which was obtained from 90 producers in Columbia County, Wis.

Tables, charts, and maps.

ARS, USDA, Inform. Div., Washington 25, D.C.

## ECONOMIC AND SOCIAL ASPECT OF SOIL AND WATER CONSERVATION

### Costs and Return

Parsons, M. S. FARM MACHINERY: A SURVEY OF OWNERSHIP AND CUSTOM WORK. U.S. Dept. Agr., Statis. B. 279, 27 pp. 1961.

Around 90 percent of the machines on United States farms are owned independently by one operator. The remaining 10 percent are owned jointly by two or more farmers. Joint ownership is associated with certain types of machines, such as pickup hay balers and field

forage harvesters, and with the larger commercial farms. It tends to be higher in the West as compared with other regions.

Custom work has become an important feature of United States farming, particularly in harvesting jobs. Custom work in harvesting accounts for about two-thirds of all custom jobs in field operations on farms. For farms having tractors, the proportion is around 80 percent. On nontractor farms, however, tillage jobs are custom hired more frequently than are harvesting jobs. Farmers who own tractors do most of their own tillage work and custom hire their harvesting jobs. Farmers without tractors tend to hire custom services for all field operations.

In recent years, custom services have accounted for about 20 percent of the acreage covered in all crop-harvesting operations. Customs work has been particularly important in grain combining, hay baling, and corn picking, accounting for 30 to 40 percent of the total volume of each of these jobs. Probably 6 to 7 percent of all fieldwork on farms is now custom hired.

Custom work is done under a variety of arrangements with respect to method of payment. For preharvest operations, payment by the acre is most common. For harvesting operations, the method payment depends on the crop. Payment by the acre is usual for harvesting corn and small grains, and payment by the bale is usual for baling hay and straw.

Custom operators usually furnish one man as a crew. About two-thirds of the custom jobs are on this basis, and about 30 percent involve two or more men. In the remaining 3 to 4 percent, the machinery is leased and the machine owner furnishes no crew.

Custom services have expanded rapidly in the last two or three decades, particularly for harvesting operations. There is some evidence that the peak may have been reached during the mid-1950's and that the volume of custom work has leveled off or declined slightly since. It may decline further as the trend toward larger, more specialized, and more highly mechanized farms continues. Custom work will undoubtedly continue to be an important factor in crop harvesting and for such operations as aerial spraying and dusting, which require unusual skills and equipment.

Numerous tables.

ARS, USDA, Inform. Div. Washington 25, D.C.

Starbird, I. R., and Vermeer, J. TRACTORS AND PREHARVEST EQUIPMENT, DELTA AREA, MISSISSIPPI: COSTS OF OWNING AND OPERATING, BY SIZE OF FARM, 1957. U.S. Dept. Agr., Econ. Res. Serv. Agr. Econ. Rpt. 2, 49 pp. 1961.

The findings of one phase of a study of farm organization, costs, and practices on cotton farms in the Delta area of Mississippi are reported. It is based on an enumerative survey of 163 operating units for the year 1957. Estimates of the costs of owning and operating preharvest items of equipment by size of farm in the Delta are presented. Analyses of equipment costs were made for four size-of-farm groups in terms of acreage of cropland: (1) Less than 60 acres; (2) 60 to 399 acres; (3) 400 to 999 acres; and (4) 1,000 or more acres. Information on equipment owned and used was obtained from farmers; secondary sources of cost and performance data were used in estimating annual costs of ownership and operation.

In general, as size of farm increased, a given size of machine was used over a greater acreage. Large machines used for small acreages of cropland were frequently found on small farms. Many items of preharvest equipment in the Delta are used on small acreages that do not gain potential economic use of equipment.

The study indicated marked variability by size of farm in unit costs of operating various items of preharvest equipment. Moderately large farms provided greater utilization of

machines and consequently lower cost per unit of use. Average costs of using 2-row middle-busters ranged from \$0.94 per hour of use on farms with less than 60 acres of cropland to \$0.46 per hour on farms with more than 1,000 acres of cropland. Average costs of using 4-row harrows ranged from \$1.10 per hour on small farms to \$0.14 per hour on large farms. Ownership and operation of equipment on farms with less than 60 acres of cropland resulted in high fixed costs per acre and per hour of use.

Total preharvest equipment costs per acre of cotton ranged from \$8.04 on small farms to \$5.26 on large farms. Greater differences in total equipment costs per acre by size of farm were found for soybeans, corn, oats, and wheat.

The estimated cost per hour of operating 2-row tractors in the Delta area of Mississippi ranged from \$1.51 on small farms with 265 hours of use per tractor, to \$1.12 on large farms with 481 hours of use per tractor. Hourly costs of operating 4-row tractors ranged from \$1.75 per hour on farms having 60 to 399 acres of cropland and an average use of 388 hours per tractor, to \$1.32 per hour on large farms with 758 hours of use per tractor. Total costs per acre of operating tractors decreased as size of farm increased, despite greater use of larger, higher priced tractors and generally more intensive practices.

The appendix tables provide data useful in farm planning and partial budgeting. Various combinations of equipment, power and labor, and costs per acre covered may be selected for application, by size of farm, to specified operations on five enterprises--cotton, soybeans, corn oats, and wheat. Substitutions in equipment use and cost rates may readily be made for application to particular situations.

ERS, USDA, Inform. Div., Washington 25, D.C.

Economic Research Service. FARM COSTS AND RETURNS: COMMERCIAL FARMS BY TYPE, SIZE, AND LOCATION. U.S. Dept. Agr. Inform. B. 230, 85 pp. Rev. 1961.

This annual publication contains estimates of costs and returns for 1960 and earlier years on 34 important types of commercial farms in 19 major farming areas in the United States, together with a brief analysis of changes that have occurred in production, income, and costs on each of these types of farms in recent years. This is the 15th annual publication.

Office Inform., USDA, Washington 25, D.C.

Johansen, C. BEEKEEPING IN WASHINGTON. Wash. Agr. Expt. Sta. Expt. B. 289, 24 pp. Rev. 1961.

Beekeeping is interesting. With good management it can be profitable. Most beekeepers enjoy following the development of a colony from week to week.

This is a complete "culture and care" bulletin written mainly for the beginner--the person who expects a small honey crop and who keeps bees largely for pleasure.

The economics of beekeeping is stressed. Where there are enough honey plants, keeping a few colonies of bees may be worthwhile. The Washington honey crop is worth over 1/2 million dollars and beeswax is worth about 33 thousand dollars. Added income for beekeepers may come from pollination service. Washington has 100,000 registered colonies of bees. Most of the State crop is extracted honey.

After one or two good seasons with a few colonies, beginning beekeepers tend to expand their activities. To be successful, commercial beekeeping requires capital, good management, and long hours of physical labor over a period of many months. A beeman with a

hundred or more colonies must be prepared for seasons with small honey yields, seasons when he must feed sugar syrup to keep bees from starving, and seasons with low prices. To provide a major portion of his income, a beeman must maintain at least 600 to 1,000 colonies.

At least 50 agricultural crops are either dependent upon honey bees for their pollination or yield more abundantly when bees are plentiful.

Wash. Ext. Serv., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Members of the Delta Subcommittee. **BUDGETS FOR MAJOR FARM ENTERPRISES IN THE MISSISSIPPI RIVER DELTA OR ARKANSAS, LOUISIANA, AND MISSISSIPPI.** La. Agr. Expt. Sta. D.A.E.C. 281, 129 pp. 1961.

Although this information has been developed for use in the Mississippi River Delta of Arkansas, Louisiana, and Mississippi, it can be easily adapted for use in other areas.

Crop and livestock enterprise budgets presented in this report are divided into two parts (1) present technology, and (2) advanced technology. Enterprise budgets for crops are arranged by farm size and soil type. For example, cotton enterprise budgets for small farms on clay, mixed, and sandy soils are presented in that order. For each crop enterprise, three tables of information were prepared and are presented as follows: (1) Estimated costs and returns per acre; (2) monthly distribution of labor requirements per acre; and (3) annual labor, power, and machinery requirements per acre.

The budgets for market hogs include a summary of the estimated costs and returns per sow on an annual basis and the monthly distribution of labor requirements per sow. Included in the labor requirements is the labor necessary to establish and maintain the pasture utilized by the hog enterprise.

In addition to a summary of the costs and returns and the monthly distribution of labor, budgets for beef cattle also include data for pastures. For each pasture crop utilized by the beef cattle enterprise, the estimated annual costs per acre, the monthly distribution of labor, and the annual labor, power, and machinery requirements were developed. All costs associated with the beef cattle enterprise are summarized on an annual basis.

Numerous tables.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Wirth, M. E., and Nielson, J. **RESOURCE OWNERSHIP AND PRODUCTIVITY ON MICHIGAN FARMS.** Mich. Agr. Expt. Sta. Sp. B. 435, 51 pp. 1961.

The changes farmers made in net worth, income, and capital structure from 1953 through 1958 together with an analysis of relationships among these valuables are reported.

A sample of 284 farms was selected to represent four important Michigan farm types. Data were collected in 1954 and 1959 through personal interviews with farmers.

The value of farm capital used by sample farmers increased on the average about \$20,000 over the period. About three-fourths of this increase was the result of changes in the prices of farm capital, and most of this price effect resulted from inflation in real estate values. The general inflation in real estate values resulted in substantially greater absolute increases in capital values of farmers with successively larger capital amounts in 1953.

Changes in net worth closely paralleled the changes made in farm capital. Total liabilities in 1959 were nearly double the average in 1954, but percentagewise, farmers' equities remained practically unchanged.

Average net farm income improved considerably on sample farms over the study period, increasing by about a third to nearly \$5,160 per farm in 1958.

Income from nonfarm sources is becoming increasingly important to farm families, as evidenced by the fact that it accounted for one-fifth of total cash income in 1958 and for only about one-tenth in 1953.

The most notable trend in farm organization was the increase in the percentage of farmers who did some off-farm work. In 1958, twice as many farmers were working 9 months or more off the farm as in 1953, with the average increasing from 3.6 to 5.3 months.

Functional analysis techniques were used in examining the marginal productivities of the various categories of farm inputs. Results show that profitable opportunities existed for expanding labor and cash expense inputs in 1958 on cash crop farms. For dairy farms in 1958, land appeared to be the only input that could be expanded profitably.

Income and beginning net worth were found to be closely related to the progress farmers made in increasing net worth from 1954 to 1959.

ERS, USDA, and Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Ottoson, H. W., Thorfinnson, T. S., Thompson, A. D., and Meierhenry, M. PROFITABLE FARMING SYSTEMS ON SANDY SOILS IN THE NORTH PLATTE VALLEY. Nebr. Agr. Expt. Sta., S B 460, 40 pp. 1961.

Some of the economics of farming on the sandier irrigated soils of the North Platte Valley was studied.

Analysis of 80- and 160-acre farms operating in this area indicates that present cropping systems do not provide sufficient protection from soil erosion. Too much of the acreage is in "erodic" crops such as beans, sugar beets, and potatoes. This is true in spite of recent reductions in acreage of potatoes and beans. Crop yields are below the levels attainable with good farm practices, and livestock numbers are relatively small except on a minority of farms.

About half of the farmers in the sample studied supplemented their income by working off the farm.

Most 80-acre farms on sandy soil do not provide enough income to support an average farm family. This is indicated by the income on the farms surveyed and is indirectly supported by the tendency of farmers in the area to increase their land holdings. Operators of the 160- and 240-acre farms studied had reached their present acreages by acquiring more land during the last ten years. This growth seems consistent with technological progress on the farm and in the household.

The land can be protected from wind erosion and kept in place for irrigation by increasing the acreage of cover crops, such as alfalfa, pasture crops, and small grains, and reducing the acreage of cultivated crops such as beans, sugar beets, potatoes, and corn. With this type of adjustment in crops, an increase in livestock production might be appropriate. Profitable cropping systems were developed for three soil associations in the sandy soil area. Also several possible livestock systems were tried. The income potential of each farming system was estimated for 80- and 160-acre farms.

These tests indicated that on the most erosive soils in the sandy soil area, a farm family can make a living on a 160-acre farm, provided livestock is included in the farming system, the cropping system is adjusted to control erosion, and better than average yields are obtained by means of good farm practices. An 80-acre unit is inadequate unless the income is supplemented from other sources.

On the least erosive and most productive soils in the area, a family can make a living on 80 acres, assuming that the cropping system keeps erosion under control, good farming

practices are followed, and livestock is included in the farming system. Some time will be available for work off the farm unless sufficient livestock is kept to occupy the farm family fully during the fall and winter.

A 160-acre farm can provide an adequate income on any of the three soil association groups. It will, of course, yield higher incomes on the better grade soils.

Expt. Sta., U. Nebr., Col. Agr., Lincoln, Nebr.

Goodwin, J. W., Plaxico, J. S., and Lagrone, W. F. RESOURCE REQUIREMENTS, COSTS, AND EXPECTED RETURNS; ALTERNATIVE CROP AND LIVESTOCK ENTERPRISES; CLAY SOILS OF THE ROLLING PLAINS OF SOUTHWESTERN OKLAHOMA. Okla. State U. Processed Series P-357, 54 pp. 1960.

Connor, L. J., Lagrone, W. F., and Plaxico, J. S. RESOURCE REQUIREMENTS, COSTS, AND EXPECTED RETURNS; ALTERNATIVE CROP AND LIVESTOCK ENTERPRISES; LOAM SOILS OF THE ROLLING PLAINS OF SOUTHWESTERN OKLAHOMA. Okla. State U. Processed Series P-368, 59 pp. 1961.

Lagrone, W. F., Strickland, P. L., Jr., and Plaxico, J. S. RESOURCE REQUIREMENTS, COSTS, AND EXPECTED RETURNS; ALTERNATIVE CROP AND LIVESTOCK ENTERPRISES; SANDY SOILS OF THE ROLLING PLAINS OF SOUTHWESTERN OKLAHOMA. Okla. State U. Processed Series P-369, 55 pp. 1961.

These publications give current farm planning information for specific soils in the Rolling Plains Area of Texas and Oklahoma.

Numerous tables.

FERD, ARS, USDA, and Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Janssen, M. R. BEEF COW HERD COSTS AND RETURNS IN SOUTHERN INDIANA. Ind. Agr. Expt. Sta. Res. B. 725, 12 pp. 1961.

Incomes from beef herds varied widely during the cattle cycle as prices of feeder cattle changed. Over the cycle, a beef herd will show a profit under average weaning weights, calving percentages, and costs of production. There was wide variability in net returns among herds. Some herds were exceedingly profitable, while others had large net losses.

Profits were likely to be greater if high calving percentages and weaning weights were achieved. When pasture was used to a maximal extent, costs of winter feed were reduced. Winter feed costs were minimized by feeding only 20 pounds of forage per day. Quality of forage needs to be only good enough to meet nutritional needs. Concentrates are not needed except to supplement poor forage.

Winter calves were more profitable than summer calves. Artificial insemination may be a profitable way to improve the productivity of a herd. However, proper planning, supervision, and suitable equipment must be available for artificial insemination to be successful. With improved management and improved production, beef herds can be even more profitable in southern Indiana.

Detailed financial records were kept on beef herds on several farms in southern Indiana from 1956 to 1959. Herds on these farms varied from 6 to 212 cows. Several systems of producing feeder calves were used and the level of herd management also varied

considerably. The records were summarized to determine costs and returns as well as reasons for differences in success of individual levels.

Average gross and net returns on farms studied varied considerably from year to year during the study period, although costs remained fairly constant (Table 1).

Table 1.--Costs and returns per cow of beef cow herds, southern Indiana, 1956-1959.

Item	YEAR			
	1956	1957	1958	1959
Number of farms.....	69	72	22	14
Gross returns per cow .....	\$76.18	\$106.60	\$128.70	\$126.98
Total costs per cow, including herd sire and replacements.....	97.84	90.59	85.37	93.12
Net returns per cow.....	-21.66	16.01	43.33	33.86
Price per cwt of calves sold.....	17.82	22.55	29.10	27.52

Tables and maps.

ERS, USDA, and Purdue U., Agr. Expt. Sta., Lafayette, Ind.

### Institutional, Educational, and Social Factors Affecting Conservation Farming

Eichberger, W. G. AGRICULTURAL POTENTIAL OF SELECTED AREAS WITHIN THE LOWER MISSISSIPPI VALLEY. U.S. Dept. Agr., Soil Cons. Serv. SCS-TP-140, 154 pp. 1961.

A description of the subproject areas covered in the survey of the Mississippi River and Tributaries Project is presented, together with a description of the proposed project works, and the effects of the proposed project on the agricultural economy of each sub-project area.

The changes in major land use and in cropping distributions as presented could be expected to occur only if the Corps of Engineers could provide the degree of flood protection assumed by USDA. Net production returns, and installation and maintenance costs of farm and group drainage were properly discounted to account for a lag in accrual of maximum benefits. Because of the uncertainty as to the degree of flood protection that might be provided by the proposed project, the yield estimates are not the full potential yields that most agricultural scientists familiar with the area feel could be economically attained.

Assuming project development of the type that would afford adequate flood protection and drainage in the area studied in the lower Mississippi alluvial valley, USDA estimated that total agricultural production could be increased 49 percent. These increases in production and annual net agricultural income are expected to result from changes in major land use and changes in cropping systems.

The estimated crop yields used by USDA are shown in table form. These yields are averages for all soils included in the project areas within each State. The increase in crop yields without a project are expected to result from technology. The increases in yields with a project over the with-out project condition are expected to result from the project.

USDA expected 2,984,000 acres were to be drained with project development. The total associated cost of land development in the entire project area was estimated at \$172,491,000,

with the annual equivalent including annual cost of farm drainage maintenance was estimated at \$18,340,000. The total value of the increase in annual net agricultural income in the project area was estimated at \$49,507,000. The discounted values of annual net agricultural income and of annual equivalent associated costs were estimated at \$26,108,000 and \$11,530,000, respectively.

SCS, USDA, Inform. Div., Washington 25, D.C.

Rogers, R. O., and Barton, G. T. OUR FARM PRODUCTION POTENTIAL, 1975. U.S. Dept. Agr., Agr. Inform. B. 233, 14 pp. 1960.

The findings indicate that the present productive capacity of agriculture is sufficient to meet the projected 1975 needs of the United States population for food and fiber and to provide for a relatively high level of exports, at the same or lower relative prices, than in 1951-53.

Farm output would need to expand by more than 35 percent above the 1956-58 level to provide for a moderate increase in per capita use of farm products by a United States population of 230 million and to meet projected export demand. Needed increases in production would be greater for livestock than for crops.

The appraisal of present productive capacity is based chiefly on projections of economic attainable crop yields--those that are likely by 1975, from the actual application of presently known technology by farmers. Economic maximum crop yields were projected also. These are the yields that could be obtained if farmers made full economic application of presently known technology.

The 1975 acreages of specified major crops and four types of pasture that would balance farm output with available market outlets were estimated using specified assumptions. These acreage requirements to meet production needs for a United States population of 230 million and a relatively high level of exports were computed on the basis of projected economic attainable and economic maximum yields and a projected 10-percent increase from 1956 to 1975 in the efficiency of converting feed into livestock products. Depending upon the assumptions used, the change in acreage requirements from 1956-58 to 1975 range from a combination in which a smaller acreage of harvested cropland would be required, to an increase needed in farm output equivalent to that from about 20 million acres.

If a 1975 population of 230 million is assumed, along with projected maximum yields and a 10-percent increase in feeding efficiency, the same total acreage of cropland and cropland pasture equivalent that was used during 1956-58 would be more than enough to provide the 1975 requirements.

If a population of 230 million, an increase of 10 percent in livestock feeding efficiency, and 1975 attainable yields are assumed, additional production equivalent to that from about 20 million acres would be needed. This is less than the 1958 acreage in the soil bank, and less also than the projected net additional acreage that would be added by 1975 to our cropland base through continuation of 1935-54 rates of land development from irrigation, drainage, clearing, and conversions.

Tables, charts and graphs.

ARS, USDA, Inform. Div., Washington 25, D.C.

The major purposes of the Great Plains Enumerative Survey were to obtain information on (1) requirements and uses for land and capital in farming in the Great Plains and the way in which land and capital are acquired, and (2) the financial, credit, and tenure situation of farmers.

For the survey, the Great Plains Region was divided into five areas representing five general types of agriculture. In each area, a sample of 12 to 30 counties was picked at random to represent varying conditions in the area. Approximately 720 farmers and ranchers were visited in each area.

An important objective of long-run agricultural policy for the Great Plains could be to facilitate the two basic types of adjustments that have been underway since settlement of the Plains began. These adjustments are: (1) The development and adoption by farmers of crops, techniques, and practices best adapted to the soils and climate of the region; and (2) the increase in size and efficiency of the region's farms. Improved farming practices and appropriate farm size go together, and the most successful farmers are those who have been able to make both of these adjustments rapidly.

Credit can facilitate the region's farming adjustments by assisting farmers to stock and equip their farms and to enlarge them. Credit, of course, cannot finance the purchase of more land by all farmers now farming. But as nonfarm employment opportunities continue to attract farm people to other occupations, additional land will be made available for enlargement of the remaining farms.

Renting additional land is a more common method of farm enlargement than is buying it, and in some respects, it may be preferable. The crop-share lease is the most common type of lease used in the region. But there may be instances in which livestock-share leases or partnerships with landowners or others would assist in the enlargement of farms and the adoption of better farming practices.

The large investment required for a farm of adequate size (average \$50,000) in Great Plains means that the problems of young farm people in the region need to be viewed in a new light. In general, unless a young man is able to obtain considerable family assistance, he will find it very difficult to obtain a farm large enough for the region.

ARS, USDA, Inform. Div., Washington 25, D.C.

Paulsen, A. Heady, E. O., Butcher, W. R., and Baumann, R. V. POTENTIAL EFFECT OF SOIL BANK AND CORN ALLOTMENT PROGRAMS. U.S. Dept. Agr., Prod. Res. Rpt. 48, 32 pp. 1961.

Information on the potential ability of certain alternative production-control programs to influence output, use of resources, and individual farm incomes is provided. The potential ability of alternative types of soil-bank, corn-allotment, and price-support programs to effect intrafarm equilibrium was determined by comparing profit-maximizing farm plans for typical farms under alternative programs with profit-maximizing plans for the same farms without a program. In this analysis of supply response to production-control programs, the technique of linear programming was used.

The three types of programs studied were: (1) An acreage allotment-price support program with supplementary acreage reserve and conservation reserve of the kinds used in 1956; (2) a base-acreage-for-corn program with soil-bank-acreage base, price support, acreage reserve, and conservation reserve of the kind rejected by farmers in the 1956 corn

referendum; and (3) a corn allotment-price support program with acreage reserve and conservation reserve of the types used in 1957.

Compliance with each of the three programs with no change in production practices would require changes in the profit-maximizing organization and would result in changes in net income for typical owner-operated 160-acre and tenant-operated 240-acre cash-grain and livestock farms in southern Iowa.

Farm income would be increased considerably for cash-grain farmers (16 percent for owner-operators and 29 percent for tenant-operators) who complied with a 1956-type program. Income would be increased moderately (12 and 21 percent, respectively) for cash-grain farmers who complied with a soil-bank base-acreage-for-corn type of program. It would be increased less (1 and 11 percent, respectively) for cash-grain farmers who complied with a 1957-type program. This would be true with no change in production practices and with the price of free corn in all instances at \$1.20 per bushel.

The net incomes of livestock farmers would be about the same whether or not these farmers participated in a 1956-type program, but their incomes would be decreased slightly (1.4 percent for owner-operators and 8 percent for tenant-operators) by participation in a soil-bank base-acreage-for-corn type of program and decreased moderately (11 and 20 percent, respectively) by participation in a 1957-type program.

The potential effects of the programs would also be influenced by the practices followed by farmers. Some changes in production practices would be likely to accompany compliance with the programs. The following changes in production practices would be profitable under a 1956-type program: (1) Under a relatively high support level for, and a restricted acreage of, corn, increases in fertilizer rates per acre are profitable. On an owner-operated livestock farm compliance with the 1956 program, net income would be \$375 higher with a medium than with a low level of fertilizer application. Production of corn would be 2 percent below the noncompliance production with a medium level of application, it would be 15 percent below. And, (2) although substitution of sorghums for corn is generally profitable in southern Iowa, it is especially profitable under certain types of production-control programs.

The value to the farm of marginal units of land would be raised by all programs. The value of marginal units of capital and labor would be reduced. Thus the alternative programs studied would probably encourage farmers who comply with them to try to obtain more land. Many livestock farmers who comply would find it profitable to shift some capital from livestock into land.

ARS, USDA, Inform. Div. Washington 25, D.C.

Bailey, W. R., and Aines, R. O. HOW WHEAT FARMERS WOULD ADJUST TO DIFFERENT PROGRAMS. U.S. Dept. Agr., Prod. Res. Rpt. 52, 35 pp. 1961.

Six different programs were studied on representative farms, in eight specialized wheat-producing areas in the Great Plains and the Pacific Northwest. Study farms are located in Kansas, Oklahoma, Colorado, Montana, Washington, and Oregon. These farms represent major producing situations in each area. As the figures are not area averages, they do not reflect average incomes among areas, although comparisons are valid between programs on the same farm.

Program features used include modifications of the present acreage-allotment and price-support program; marketing allotments and stratified wheat prices; and no controls or price supports. "Prototype programs" constructed around each feature specify the price of wheat and other crops and either the maximum acreage of wheat, or the maximum quantity that could be marketed.

To determine the adjustments that would maximize incomes on the study farms with the programs, budgets were prepared for each farm. A charge for all labor at hired wages per hour is included in expenses, but no charge is made for management and invested capital. Crop yields are the average that operators of the study farms can expect with average weather and present practices. Crops other than wheat could be grown under each program without restriction for sale at the following assumed prices (U.S. average):

Grain sorghum ..... \$1.01 (bushel)  
 Barley ..... .90 (bushel)  
 Dry peas (Washington farm)..... 3.60 (cwt)

Effects of each specified program on wheat acreage, total grain production, and net income to management and invested capital of study farms are compared with effects of program A (1960 acreage allotments and price supports). These comparisons are summarized in Table 1.

Table 1.--Effects of specified programs on wheat acreage, grain production, and income, study farms

Item	1960 acreage allotment program (program A)	Percentage change with--				
		Smaller acreage allotment (program B)	Larger acreage allotment (program C)	Food and export allotment (program D)	Food allotment (program E)	No controls (program F)
	Acres	Percent	Percent	Percent	Percent	Percent
<b>Acreage of wheat:</b>						
West-central Kansas .....	280	-25	20	4	7	22
Northwestern Kansas.....	270	-25	20	-23	-16	-1
Northwestern Oklahoma <sup>1</sup> ..	473	-25	20	25	55	55
Eastern Colorado.....	550	-25	20	-3	16	16
Northeastern Montana.....	405	-25	20	14	43	43
North-central Montana.....	405	-25	20	14	43	43
Eastern Washington.....	166	-25	20	73	98	98
Columbia Basin, Oreg. ....	520	-25	20	23	54	54
<u>Tons</u>						
<b>Production of all grain:</b>						
West-central Kansas .....	215	0	0	-28	3	0
Northwestern Kansas.....	246	11	1	-21	8	9
Northwestern Oklahoma <sup>1</sup> ..	314	1	-3	-21	-5	-5
Eastern Colorado.....	368	16	-8	-25	-11	-11
Northeastern Montana.....	260	1	-1	-22	-2	-2
North-central Montana.....	370	1	-1	-22	-2	-2
Eastern Washington.....	434	-1	1	-4	10	10
Columbia Basin, Oreg. ....	734	0	1	-19	-2	-2

See footnotes at end of table.

Table 1.--Effects of specified programs on wheat acreage, grain production, and income, study farms--Continued

Item	1960 acreage allotment program (program A)	Smaller acreage allotment (program B)	Percentage change with--			
			Larger acreage allotment (program C)	Food and export allotment (program D)	Food allotment (program E)	No controls (program F)
	<u>Dollars</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>
<b>Net income:<sup>2</sup></b>						
West-central Kansas .....	4,675	7	-22	15	-4	-52
Northwestern Kansas.....	5,755	5	-22	4	-11	-49
Northwestern Oklahoma <sup>1</sup> ..	5,748	6	-25	39	5	-66
Eastern Colorado.....	10,513	9	-15	20	-2	-47
Northeastern Montana.....	6,022	-2	-13	38	14	-42
North-central Montana.....	9,756	0	-14	25	11	-35
Eastern Washington.....	12,175	-2	-8	34	19	-19
Columbia Basin, Oreg. ....	17,812	2	-13	37	9	-44

<sup>1</sup> Excludes panhandle counties.

<sup>2</sup> Return to management and invested capital. Computation explained in section on Budget Analysis.

Program A-same as 1960 Allotment Program.

Program B-Wheat prices raised to 85 percent of parity and acreage allotments decreased 25 percent from the 1960 level.

Program C-Wheat prices lowered to 65 percent of parity and acreage allotments increased 20 percent.

Program D-A marketing allotment on food wheat, export wheat priced at 65 percent of parity and other wheat at a feed price, 80-cent a bushel payment on food-wheat quota, and 20 percent of the wheat base acreage in a land reserve, at the 1960 rate of payment.

Program E-Marketing allotments on food wheat priced at 90 percent of parity, other wheat at a U.S. price of \$1.25, and no land-reserve requirement.

Program F-With no production controls and no price supports, net incomes would decrease on all study farms.

ARS, USDA, Inform. Div., Washington 25, D.C.

The Conservation Reserve Program in two areas of Georgia (Piedmont and Coastal Plain) was studied.

In 1960, approximately 12 percent of the cropland in Georgia was in the conservation reserve. At the same time, almost 24 percent of the cropland in the sample counties in the Coastal Plain and 17 percent of that in the sample counties in the Piedmont were in the program.

Whole farm units accounted for about 60 percent of the acreage placed in the program in Georgia. Approximately 78 percent of the acreage in the Piedmont sample counties was contracted as whole farm units, compared with about 50 percent in the Coastal Plain sample counties.

More participants than nonparticipants in the conservation reserve resided off their farms and were engaged in part-time farm or full-time off-farm work. In the Piedmont, the larger proportion of the participants were 65 years of age or over, and more were retired or disabled; in the Coastal Plain sample, the opposite was true with respect to age and retirement. On the average, nonparticipants have operated their farms longer than participants.

Farms in the conservation reserve in both areas averaged more total land, more total cropland, and larger capital investments than farms not in the program. Farms of part-farm participants were more than twice the size of farms of whole-farm participants.

Most participants reported important reductions in the acreages planted to their main cash crops as a result of the conservation reserve. Very little change occurred in total acreage per farm including rented land.

Average yields of most crops were slightly higher than before.

Land placed in the conservation reserve by participants with part-farm units may be less productive than land retained for production of cash crops. Average crop yields on these farms were generally higher during participation in the program than before.

As more than half the reduction in acreage in the Piedmont and about 62 percent in the Coastal Plain came from cotton, corn, peanuts, and small grain, the program has served to reduce production of these crops substantially in both areas.

Most participants reported substantial decreases in the total amount of fertilizer used per farm as a result of placing land in the conservation reserve. Little change was reported in amount of fertilizer used per acre of cropland harvested.

Slight reductions occurred on participating farms in amount of labor available, number of farm machines, and use of farm buildings. Reduction in the farm labor force were mainly in amount of hired labor including sharecroppers.

Very few respondents reported changes in residence or in employment since placing land in the conservation reserve.

The need for a larger income, a desire to establish soil-conserving crops including trees, and problems encountered in hiring and maintaining an efficient farm labor force were the main reasons given for placing land in the conservation reserve. Other important reasons were poor health and advanced age of the operator.

The main reasons for not participating in the program were the belief that the conservation reserve would be a less profitable alternative than other uses of the land, a conflict of personal interests with program restrictions, the desire of owners to continue farming their land, and lack of understanding of the program.

Tables, charts, and maps.

ERS, USDA, Inform. Div., Washington 25, D.C.

In a study of the effects of price and income programs on marginal farms, the authors conclude:

1. In 1959 farm price support and related programs cost in excess of \$2 billion. Indications are that the direct effects of price and income support programs accrue mostly to the 44 percent of the nation's farms whose products account for more than 91 percent of the value of all farm sales.
2. The evidence indicates that price and income support programs have contributed to the rapid adoption of new technology in specialized areas in recent years. Marginal areas either have not adopted new technology or have adopted it at a relatively slow rate. It would appear that price and income programs have encouraged the shifting of production from marginal areas to the specialized areas. The shift in production from marginal areas to more specialized areas would increase the efficiency of production and would force marginal areas out of production, thereby reducing their income until alternatives are developed.
3. It is the innovator and early adopter who profits, while the late adopter and non-adopter would be relatively more inefficient and relatively worse-off than before the new technology was introduced.
4. From the standpoint of welfare of society as a whole such shifts should be desirable. However, to the extent that low-income farmers are used as justification for price and income support programs and to the extent that the programs developed actually work to their disadvantage the programs have been disillusionments.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Farm Economic Research Service. FARM PRODUCTION: TRENDS, PROSPECTS, AND PROGRAMS. U.S. Dept. Agr., Agr. Inform. B. 239, 102 pp. 1961.

A broad view of the current situation in agricultural production and the prospects for the 1960's is reported. It discusses such questions as: What is the present production situation? What are the origins of the present situation? What have we tried to do about our production and how well have our actions worked? What alternative courses of action should be considered? In attempting to foresee the farm environment in the next decade, we need first to appraise the current situation in the light of major trends and in terms of its underlying causes.

In this report, primary emphasis is on production prospects and programs; available information on the demand phase of the farm problem has been marshalled as a general background against which to examine production changes and prospects. Production is emphasized because, apparently, farm production has outrun the ability of expanding markets to absorb farm products.

Since agriculture is made up of hundreds of thousands of individual farmers, it seems likely that production will continue to press heavily on market demands unless measures are taken to control output. So long as many individual farmers can profit by expanding output, even with declining prices aggregate supplies of the major commodities will not be reduced automatically. Changes in relative prices may shift production from one commodity to another, but unless they are continued for years low prices do not reduce farm output.

ARS, USDA, Inform. Div., Washington 25, D.C.

Legislation enacted or considered by various State legislatures in an effort to cope with the problems of taxing agricultural lands lying in the path of urban expansion is summarized.

Pertinent sections of State laws and bills that deal with criteria for assessing such farmland are quoted in full or in part. Several States have sought to handle the problem without enabling legislation through special instructions to local tax assessors. Samples of these instructions in tax assessor manuals are contained in the appendix. No attempt is made, however, to evaluate either the desirability or the effectiveness of these various measures.

ERS, USDA, Inform. Div., Washington 25, D.C.

Hadley, F. T. IMPROVING INCOMES OF FARM PEOPLE IN NORTHERN AND WESTERN FLORIDA. U.S. Dept. Agr., Econ. Res. Serv. ERS-36, 27 pp. 1961.

Income from farming is low in northern and western Florida. Farmers in this area contribute less than a tenth to total income. Personal income from Government payments exceeds any other single source of income in northern and western Florida.

The population of the 20 counties in the area increased about 30 percent between 1950 and 1960, with changes varying by county from a decrease of 23 percent to an increase of 122 percent. All except two of the Florida counties that lost in population are in this area.

In 1954, about one-sixth of the total population in the study area lived on farms. Of this group, about 40 percent were on low-income farms. Part-time or residential farmers with low incomes made up another 47 percent. The rest were on farms with product sales of \$5,000 or more.

While the aggregate resources (labor, land, and capital) used by low-income people are large, they constitute a rather small part of the total resources of the area.

Solution of the low-income problem through agricultural development does not look promising. Nonfarm employment for willing, employable persons seems a more feasible solution.

Local communities will need to provide employment opportunities if they expect to keep people from moving elsewhere for jobs. One way of doing this might be to establish housing developments that would attract retirement families into the area. These people come with money to spend and without need for jobs to maintain their incomes.

In adjustment of both land and human resources, development of recreational opportunities seems to hold promise. This is a job for Federal and State agencies and local communities working together for the benefit of both present and future generations.

Chronic low incomes in agriculture are recognized as one of the Nation's major economic problems. They bear upon the performance of the Nation's whole economy and reflect upon its capacity as a leader in human progress. In recent years, the Department of Agriculture in cooperation with other Federal Departments and States has begun a concerted effort through the Rural Areas Development Program to improve the economic situation of low-income areas. An important part of this effort has been increased research into the causes of the problem and the requirements for its solution. Although this publication reports on research in only a part of one State, it deals with problems that are common to many other low-income areas.

ERS, USDA, Inform. Div., Washington 25, D.C.

The number of part-time farmers in the Clay-Hills Area of Mississippi has been increasing, while the number of full-time farmers and the total rural population has been decreasing. These trends may continue indefinitely.

In 1958, three-fourths of the average part-time farmer's net family money income came from off-farm work, about 20 percent from the farm, and the remaining 5 percent from nonwork sources. The average net family money income was \$2,435.

Over two-fifths of the part-time farmers had net farm incomes of less than \$250, and one in three had negative net farm incomes. Those operators with negative farm incomes could have increased their money incomes simply by not farming.

Over a third of the operators used only workstock in their farm operations. A majority of the operators who purchased tractors and equipment were able to do so because of their off-farm work income. Over a third of the farmers with tractors had negative net incomes but their family money incomes were relatively large.

The average net money income of part-time farmers per hour of work was \$0.61. However, their average income from farm work was only \$0.17, while their average income from off-farm work was \$1.02 per hour employed.

The occupational experiences of the family heads followed three general patterns: (1) School to farm to part-time farm (57 percent); (2) school to part-time farm (22 percent); and (3) school to off-farm to part-time farm (21 percent).

About one-third of the operators reported that they would look for nonfarm jobs if their present nonfarm employment were terminated. Another 28 percent said they would probably start farming full time. The rest were undecided as to what they would do.

Part-time farmers had almost the same average yields per acre of crops as did the full-time farmers in the area. Cotton was the most important cash crop and dairying the most important livestock enterprise. Sales of beef cattle were also important. Cash farm receipts for part-time farmers averaged about \$1,300, approximately half that of full-time farmers.

In general, capital was limited for part-time farmers in the Clay-Hill Area of Mississippi. The average investment per farm was a little over \$8,000 and the average net worth was about \$7,300.

Generally, part-time farmers use their farm resources less efficiently than do full-time farmers. This is borne out by both the computed returns per hour of labor employed on the farm and the ratio of farm expenses to farm receipts.

Many families use part-time farming as an intermediate stage to move out of full-time non-farm work or to retirement. A smaller, though nonetheless substantial group, use part-time farming as a stage in moving into a semi-retired group of full-time farmers.

For those families who wish to remain in agriculture, combining off-farm employment with farming may provide a satisfactory level of living.

ERS, USDA, and Miss. State U., Agr. Expt. Sta., State College, Miss.

Agricultural Research Service. A LEADERS' GUIDE TO AGRICULTURE'S DEFENSE AGAINST BIOLOGICAL WARFARE AND OTHER OUTBREAKS (A TECHNICAL PRESENTATION). U.S. Dept. Agr., Agr. Res. Serv., ARS 22-75, 15 pp. 1961.

Biological warfare employs disease agents, insects and parasites to weaken or destroy humans, livestock, crops, or food supplies. This report deals with the use of pests and diseases against agriculture, including some that also harm man. Biological warfare can be effected from within a country's borders or launched subtly from without. It can take on the

guise and even utilize the normal practices of agriculture or agricultural commerce and cause great losses to farmers, distributors, processors, handlers, and consumers of agricultural products.

The deliberate and planned use of a livestock or crop disease or pest as an act of sabotage can be managed with devastating effect on a nation's peacetime economy or its war effort. Spores of a grain rust or other disease-producing organism or destructive insects could be released on the winds, which could spread the disease or pest rapidly over a wide area. A virus released unobtrusively in a stockyard, a large feeding center, or other livestock assembly area would likewise spread fast and far. The crop or class of livestock, the disease or pest, and the time and place for an outbreak can be selected to cause the greatest interference with the nation's war effort. Simultaneous introduction of related animal diseases--for example, the vesicular group of foot-and-mouth disease, vesicular exanthema or VE, and vesicular stomatitis or VS--with their similar symptoms but certain contradictory signs and various incubation periods can confuse diagnosis, complicate control measures, and even act synergistically to increase the injury. Similarly, the simultaneous introduction of a crop or animal disease and its insect vector could be most devastating. Outbreaks of these diseases or combinations of them can, of course, arise accidentally.

Especially feared are a number of highly contagious foreign diseases and prolific pests which this country has guarded against for years. Occasionally one of them has slipped past our guard or an old established one has broken out with new vigor. It is important to know that these threats exist and that the necessary knowledge and machinery exist in this country to combat the threats.

Everyday precautions against biological warfare are: (1) Practice normal sanitation to minimize spread of disease from animal to animal, from farm to farm, and from community to community; (2) check animals regularly as early discovery and prompt reporting are necessary to wipe out disease before it gets a strong foothold; (3) isolate sick or newly acquired stock for 10 days or more to be sure they are not disease carriers; (4) promptly report unusual diseases or a rise in old diseases in your animals to a veterinarian or livestock sanitary official; (5) vaccinate as approved for local diseases; (6) carefully dispose of the wastes and discharges of sick animals and carcasses of animals that have died from contagious diseases; (7) don't visit infected or quarantined farms; (8) cooperate with plant-disease-control officials; (9) promptly inform your county agent of any damage to your crops by unfamiliar diseases or insects; and (10) do not send insects or diseased plants to anyone but your county agent unless instructed to do so by a responsible agricultural authority.

ARS, USDA, Inform. Div., Washington 25, D.C.

House, P. PREFERENTIAL ASSESSMENT OF FARMLAND IN THE RURAL-URBAN FRINGE OF MARYLAND. U.S. Dept. Agr., Econ. Res. Serv. ERS-8, 20 pp. 1961.

Maryland experience illustrates that preferential assessment of farmland in the rural-urban fringe areas is of tangible benefit to the individual owners of farmland. Even in Carroll County, where urbanization has had least import, the law reduced assessments on 'exempted' farmland by an average of a third from what they would have been otherwise. The loss in assessable base ranged from a high of about 7.0 percent in Howard County to a low of 1 percent in Montgomery County.

A law of the type enacted in Maryland is one answer to the problem of prohibitive taxation of agriculture in rural-urban fringe areas. To the extent that it helps to preserve agriculture, it contributes to the maintenance of open spaces around growing cities and therefore benefits the urban as well as the rural segments of the metropolitan community.

The effectiveness of tax measures in preserving open spaces, however, depends upon their being coupled with area-wide planning and controls over land use.

Serious administrative difficulties have arisen, notably in defining agricultural use in such a way as to limit the benefits of preferential assessment to owners of bona fide farms. This problem, and that of determining agricultural value are among the most troublesome features of the law.

ARS, USDA, Inform. Div., Washington 25, D.C.

Economics Research Service. CURRENT DEVELOPMENTS IN THE FARM REAL ESTATE MARKET. U.S. Dep't. Agr., Econ. Res. Serv. CD-59, 30 pp. 1961.

Market values of farm real estate advanced a little more in the 4 months ended July 1, 1961, than in the comparable period of 1960, particularly in the Corn Belt, where a downward trend developed last fall. The national index for July 1, 1961, advanced to 177 (1947-49 = 100), 1 percent above the March index and 2 percent above the July 1960 index. Most of this gain was contributed by further increases of 2 or 3 percent in 28 States located primarily along the eastern seaboard, in the south-central part of the country and in the Mountain and Pacific Regions. Values in the Corn Belt were up slightly, whereas in previous periods they had shown a downward trend. However, values in these States still averaged 2 or 3 percent below those of a year earlier. Elsewhere, increases of 2 or 4 percent were typical.

The total market value of farm real estate (land and buildings) was estimated at \$138.4 billion (\$123.57 per acre) on July 1, 1961. This is \$3.3 billion, or 2 percent, more than a year earlier. Farm buildings currently represent about 21 percent of the total value of land and buildings.

The rate of voluntary sales of farm real estate has been at a low level in recent years, and in the year ended March 1, 1961, it was the lowest since the early thirties. The rate of 28.1 farms per 1,000 indicates that probably not more than 100,000 voluntary sales occurred in the latest 12-month period.

Types of buyers and sellers in 1960-61 were about the same as in the last several years. Active farmers (tenants and owner-operators) made 65 percent of the purchases, and nonfarmers accounted for 32 percent. Farmers also were the predominant group of sellers; in 1960-61 they made 63 percent of the sales. Nonfarmers accounted for a slightly smaller proportion of all sales (24 percent) than in the previous year. Nearly a third of the farm properties offered for sale in recent years were acquired before 1940, and about an equal proportion since 1950. Nearly two-fifths of all sellers were 60 years of age or older.

A major share of all land purchases in several areas of the country is for enlargement of existing farms. Nationally, 46 percent of the sales reported in 1960-61 were for this purpose, compared with only 26 percent a decade ago. Such purchases tend to be of smaller acreage than complete farm units, less frequently have buildings, and are often predominantly cropland or pasture to complement the classes of land in the farm operated by the buyer. Prices paid for tracts and farms to be used for farm enlargement tend to set the general level of prices for all land within a community.

There were no significant changes in the overall financing characteristics of properties sold in 1960-61 compared with those sold in the previous 2 or 3 years. About two-thirds of all sales involved some credit; the average downpayment was about a third of the purchase price. Sellers continue to be the chief source of credit to finance farm purchases, and the installment land contract has become the dominant type of credit instrument used. The downpayment for purchases financed by land contracts averaged 23 percent, whereas when the

seller took back a conventional mortgage, it was 35 percent. When mortgage credit was obtained from a source other than the seller, the downpayment was 41 percent of the purchase price. All major lenders reported a substantial increase in the dollar volume of new farm mortgage loans made in the first half of 1961 compared with a year earlier.

Tables, maps, and graphs.

ERS, USDA, Inform. Div., Washington 25, D.C.

Hill, E. B., and Harris, M. FAMILY FARM TRANSFERS AND SOME TAX IMPLICATIONS. Mich. Agr. Expt. Sta. Sp. B. 436 (North Cent. Reg. P. 127) 48 pp. 1961.

The usual midwestern farm family has two or more children and only one farm. All of the children are prospective heirs to the farm. Some of our most serious farm-ownership problems grow out of transferring farms within families from one generation to the next. Faulty within-the-family farm-transfer procedure not only causes heartaches but often the parents and the farm-operating heirs are losers and depletion of the farm usually occurs.

It isn't always wise to keep the farm in the family. Much depends on the answers to these questions: Is there a willing and able son who wishes to operate and own the home farm? Is the farm large enough to support two families and provide for the parents' retirement? Is it the wish of the entire family to keep the farm? If these questions can be answered affirmatively, the family has a good chance of achieving the goals of an ideal family farm-transfer, which are: (1) A reasonable degree of financial security for the parents; (2) a reasonable degree of opportunity for the farm-operating son; (3) equitable treatment for the other children; (4) minimizing taxes and probate costs; and (5) maintenance of the farm as an efficient going concern.

Having decided to keep the farm in the family, each family should study the different ways of transferring a farm from one generation to the next, so that they can select the best method for themselves and their particular farm. The following types of transfers may be used: (1) Transfer plans made during the life of the parents but which do not take effect until the death of one or both of the parents, such as by means of a will; (2) transfer completed during the life of the parents, such as by sale or gift or a combination sale and gift; and (3) transfer after death by the state laws of descent. Taxes and probate costs are often important but usually are not the most important considerations in determining the best transfer method.

It is desirable to plan for the transfer and frequently to make the actual transfer of the farm during the life of the parents. This may often provide for greater security for the parents as well as for better maintenance of the farm.

A good course for the parents to follow in planning and making a transfer within the family is as follows: (1) Have a discussion with the entire family, possibly after the marriage of the son who is helping to operate the farm, as to whether they wish to keep the farm "in the family" in the future. (2) Later, after the son has acquired suitable managerial competence and capital, give consideration of ideas as to how and when best to make the transfer. At this time, a will is usually a good step in the transfer process. (3) At a suitable time in the lives of the parents, transfer the farm to the son in a manner which best fits the goals of the family members concerned. And (4) as the ideas for the farm transfer plan develop, consult a lawyer, discuss the plan with him and have him put the plan into a written legal form.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

A punched card system was adapted for indexing literature references and research reports. It permits the recording of information regarding the reference on a 5 by 8 inch punch card. A coding system is described which can be used by soil scientists with such diverse interests as chemistry, microbiology, and plant physiology.

A subject matter code provides for major categories with breakdowns into several lower levels where necessary. Also presented are codes for author, year, and miscellaneous subjects. The distinct features of the punch card system are outlined and several pertinent examples of its application to an agronomic reference and reprint file are considered.

SWCRD, ARS, USDA, St. Paul, Minn.

## BIOLOGY

### Fish

Gard, R. EFFECTS OF BEAVER ON TROUT IN SAGEHEN CREEK, CALIFORNIA. *J. Wildlife Mangt.* 25: 221-242. 1961.

The effects of beaver on trout was studied on Sagehen Creek, Calif., from 1954 to 1957. Several ways in which beavers and their activities influence the three species of trout present in the creek were investigated. Comparisons were made between sections of the natural stream and sections that had been ponded by beavers, in regard to: (1) physico-chemical conditions; (2) production of trout foods; (3) feeding habits of the trout; and (4) populations of trout. The consequences of beaver dam removal on trout foods and populations were assessed, as well as the ways beaver dams affect trout spawning activities.

Physical environment of the trout was altered measurably following construction of beaver dams. The substrate changed from gravel and rubble to silt, water velocities decreased, ice conditions became less severe, and the depth and area of the aquatic habitat increased. Water temperature extremes lessened in the ponds, but water chemistry was little affected.

These changes in physical environment resulted in profound changes in the bottom fauna. Although fewer different kinds of organisms were found to live in pond bottoms, much greater standing crops of organisms were living there than in the stream.

All trout relied heavily on bottom faunas for food. In summer, drift organisms also became important. Trout living in the stream ate stream fauna almost exclusively. Rainbows living in the ponds depended largely on stream organisms for food, but pond brook and brown trout were supported mainly by pond faunas. Foraging was not random; some organisms, though seemingly unavailable, were selected by trout in both habitats.

The higher standing crop of bottom fauna and the unique physical environment in the ponds were reflected in greater trout populations. These resulted in a relatively higher catch in the ponds than in the stream.

A flood in 1955 removed most of the dams in one beaver colony. Following dam removal, there was substantial decrease in surface area, trout food, and number of trout. Rainbows replaced browns as the dominant species.

Some marked trout crossed up and down over most beaver dams at all seasons. There was no evidence that the barrier influence of dams depressed the level of adult trout populations.

It was concluded that beaver are of substantial benefit to trout in Sagehen Creek.

U. Calif., Berkeley, Calif.

Montgomery, A. CONTROL OF AQUATIC WEEDS IN FARM PONDS. *J. Soil and Water Conserv.* 16: 69-70. 1961.

Aquatic plants can be either desirable or undesirable, depending upon the conditions under which they exist and the manner in which the water area containing them is used. In certain instances, some aquatic plants are highly desirable in that they furnish food and cover for fish and game, however in small farm ponds most plants are undesirable in that they interfere with proposed water uses of the pond.

1. Fertilization of the water for production of microscopic algae in numbers sufficient to reduce light penetration into the water and in effect shade out plant growth on the pond bottom. This method effectively prevents new growth of aquatic weeds, however, it isn't effective in eliminating established weed infestations.
2. Manual removal of undesirable plants through cutting or pulling. This method is quite effective in eliminating plants of the emergent type (cattails, arrowhead, waterlilies, pickerel weed, etc.), if removal is initiated and continued so as to prevent seed production. Three to five cuttings may be necessary during the first year, and in most instances it is desirable to initiate a fertilization program to retard regrowth after cutting.
3. Exposure of the pond bottom to winter weather conditions. In areas of the United States having severe winter weather conditions, ponds having ample water supplies and adequate draining facilities are often drawn down during the winter months to expose weed infested bottom areas to freezing and thawing. It is now thought that winter draw-down must be practiced for a 3-year period to eliminate weeds.
4. Chemical aquatic weed control in which suitable chemicals are applied to the plants which they effectively eliminate. Chemical aquatic weed control usually is the most economical and effective means of eliminating water weeds. There is one chemical which will control all aquatic weeds.

For general control of submerged aquatic weeds (plants that grow beneath the water), sodium arsenite solution has been used almost exclusively.

To control the emergent aquatic vegetation (plants growing from the lake bottom with leaf parts extending above the water surface) and, for the most part, floating aquatic plants (waterlilies, watershield, waterlettuce), 2,4-D and 2,4-D--2,4,5-T combinations have been extensively used.

The control of some forms of algae (filamentous and plankton) is still most economically and effectively accomplished through the use of copper sulphate.

Chem. Insecticide Corp., Metuchen, N.J.

## Upland Wildlife

Donnelly, J. A. THE MOURNING DOVE. W. Va. Conserv. 25(8): 18-19, 26-27. 1961.

The mourning dove is one of our smallest game birds. Although its average weight is only four ounces, the small size has little to do with its popularity. It is the second most important game bird in the southern half of the United States.

Indications are that the present continental population may be higher than it has ever been, and the annual harvest appears to have no detrimental effect on the population.

The mourning dove is the most widely distributed of our native game birds and breeds from southern Canada to northern Mexico. The major wintering areas for the species extends from Mexico and Central America across the southermost portions of the United States.

Nests are usually located in trees--evergreens preferred, especially during the early attempts. The dove is not adverse to nesting on the ground if other nesting sites to their liking not be at hand. The female constructs the nest with materials furnished by the male. It is a loosely constructed affair with almost no sides and the eggs can sometimes be seen through the bottom of the nest. Nest materials consist of weed stalks, pine needles, willow fibers, twigs, or any other available material.

Almost 95 percent of the nests contain clutches of two eggs but occasionally only one egg is found.

The female incubates during the day and the male at night. The incubation period is about 14-15 days. When hatching occurs, the egg shells are removed and carried away by the adults. Nestlings are blind, weigh about 7 grams, and are covered with yellow natal down. Development is very rapid, and their weight is doubled during the first 24 hours.

The newly hatched young are fed a milky secretion from the crop glands commonly referred to as "pigeon milk." As the nestlings get older they are fed an increasing number of weed seeds and waste grain. Young birds are capable of flight at 10-12 days of age and most of them leave the nest at 12-13 days. After leaving the nest, the young are partly dependent upon the adults for a week or two, but another brood may be started while the flying young are still being cared for. At 20-21 days of age the young leave the vicinity of the nest and flock with others to feed. Thus, with a 6-month breeding season and a nesting cycle completed in 30 days, these birds are capable of raising five or six broods in one year. However, this potential is seldom reached.

This heavy production is needed to maintain the species because of their high mortality. Usual nest mortality is about 50 percent and first year mortality of young birds averages 70 percent. These losses occur irrespective of whether the birds are hunted or not.

No address given.

Dillon, O. W., Jr. MOURNING DOVE FOODS IN TEXAS DURING SEPTEMBER AND OCTOBER. J. Wildlife Mangt. 25: 334-336. 1961.

The important seeds used by mourning doves indicate that they feed primarily in or near agricultural crop fields in Texas. When agricultural crop residues are available, they furnish important dove foods. When they are not available, the hard seeds of spурges and grasses are highly important. Five of the most important foods were agricultural crops; 12 were weeds of cropland; 7 were weeds that grow both in cropland and pastures or rangeland; 2 were typical of pasture and rangeland; and 2 grow in field borders or hedgerows. Seeds of these 28 plants represent 99 percent of the food of the 651 mourning doves in this study. All but two, paspalums and prickly ash, were annual plants. Prickly ash was the only woody plant that produced seeds used in a significant amount.

The extensive acreages of grain sorghum, wheat, oats, and rye in Texas assure mourning doves of an abundance of food after crops are harvested. The use of mechanical harvesting devices provides an abundance of shattered grain on the ground from spring (wheat, oats, and rye) to fall (grain sorghum and corn).

Even with modern cultural practices, weeds grow in profusion in fields and especially in field borders and fencerows. Following the spring harvest of wheat, oats, or rye, an excellent volunteer crop of croton and brown top panicum grows in the stubble. Stubble is not plowed under or destroyed, as was formerly done; consequently the field will have protective cover to prevent wind erosion.

Tillage of fields brings to the surface seeds of crotons, panicums, queen's delight, and others. These same seeds may be exposed by rain.

Not all agricultural practices favorable to doves can be considered good farming methods. Pasture and range weeds such as crotons, queen's delight, and others become abundant when pastures or ranges are heavily grazed or subjected to prolonged drought.

SCS, USDA, Cornell U., Ithaca, N.Y.

Holmes, A. C. V. THAT STRANGE LITTLE BEAST THE OPOSSUM. Ill. Wildlife 16(3): 10-11. 1961.

This is a brief description of the opossum's home range and dens, food habits, distribution, and its role as a game animal and furbearer. Cold may be the limiting factor for the northwest movement of the opossum.

Ill. Natural Hist. Survey, Urbana, Ill.

Powell, J. A. FACTS ABOUT FLORIDA WILD TURKEY. Fla. Wildlife 15(6): 12-17. 1961.

A detailed and illustrated guide about the Florida wild turkey.

Biologist, Fla. Game Mangt. Div.

Bartholomew, G. A., and MacMillen, R. E. WATER ECONOMY OF THE CALIFORNIA QUAIL AND ITS USE OF SEA WATER. Auk 78: 505-514. 1961.

On a dry diet, captive California Quail showed a mean weight loss of 1.6 percent of initial body weight per day. Mean length of survival without water was 28.1 days for females and 40.6 days for males. Ad libitum consumption of distilled water averaged 5.2 percent body weight per day, and the minimum consumption of water on which body weight could be maintained averaged 1.8 percent body weight per day.

Ad libitum drinking by normally hydrated birds of 25, 37.5, 50, and 75 percent sea water did not differ significantly from that of distilled water, but birds drinking 50 and 75 percent sea water lost weight. Daily weight loss of birds drinking 75 percent sea water exceeded that of birds from which water was withheld completely.

After being deprived of water for a week, 7 of 10 birds were able to maintain weight on 50 percent sea water, 4 of 10 were able to maintain weight on 60 percent sea water, and 1 bird was able to maintain weight on 70 percent sea water.

Either succulent vegetation or insects offer an adequate water source for California Quail.

California Quail showed no significant preference for distilled water as compared with 12.5 and 25 percent sea water, but chose 25 percent sea water in preference to 37.5 percent.

The low water requirements and the tolerance of dehydration of California Quail allow them to remain independent of surface water as long as green vegetation or insects can be found. Under conditions of severe drought or heat stress, brackish or saline water may contribute to survival, but California Quail apparently cannot utilize the sea as a water source. Although they are not successful in deserts, California Quail have lower water requirements, greater tolerance of dehydration, and can utilize water of higher salinity than the Mourning Dove, which is a conspicuously successful desert species. This situation is probably related to the limited mobility of the quail, which precludes periodic visits to distant water sources.

Dept. Zool., U. Calif., Los Angeles 24, Calif.

Redd, J. B., Jr. YOU MAY NEED MORE COVER FOR RABBITS. Va. Wildlife 22(12): 8-9. 1961.

There are many ways to improve rabbit habitat. They range from simple changes around the farm to large scale developments more suited to the beagle clubs who seek year around rabbit populations on which to train dogs and run competitive trials. There is planning, hard work, and time involved in improving any area for rabbits. The important goal to shoot for in planning rabbit habitat improvements is the manipulation of food and cover conditions so that preferred foods and high-quality cover are well distributed throughout the area at all seasons of the year.

Cover has different uses during various seasons of the year. It must be designed to conceal nest and young, protect animals from the heat of the sun, and provide shelter from chilling rains. It must be thick enough to allow escape from enemies and strong enough to protect the animals from the snow and wind in winter. All types of cover must be present to furnish complete protection for rabbits.

Various ways to provide nesting cover, escape cover, and shelter cover are given.

District Game Biologist, Powhatan, Va.

Verme, L. J. PRODUCTION OF WHITE-CEDAR BROWSE BY LOGGING. J. Forestry 59: 589-591. 1961.

A study on the amount of white-cedar browse made available to deer by logging an all-aged, mature northern white-cedar stand revealed that yield varied directly with intensity of cut. Clearcutting produced the greatest yield, approximately 5,340 pounds of browse per acre, while cutting to a 10-inch minimum stump limit produced only 2,530 pounds. This amount of browse would be sufficient to nourish about 11 and 5 deer per acre, respectively, during 100 days of winter. Logging in this manner on 40 acres would therefore support 427 and 202 deer, respectively, over winter. Browse production values for the 6- and 8-inch cutting limits are between those above.

Cusino Wildlife Expt. Sta., Mich. Dept. Conserv., Shingleton, Mich.

Biswell, H. H., and Gilman, J. H. BRUSH MANAGEMENT IN RELATION TO FIRE AND OTHER ENVIRONMENTAL FACTORS ON THE TEHAMA DEER WINTER RANGE. Calif. Fish and Game 47: 357-389. 1961.

Browse conditions and reproduction in relation to fire and other environmental factors were studied on the Tehama deer winter range over a period of 12 years.

Fire resulted in more brush seedlings and sprouts and better range for deer. However, fire must be used judiciously or the nonsprouting species will be diminished in abundance and the carrying capacity may be decreased.

In the absence of fire, a few too many brush seedlings emerged in different years, but nearly all died. Mortality was mainly caused by plant competition. Other factors of less importance were frost heaving, browsing by deer, cutting by rabbits and rodents, and defoliation by grasshoppers and quail.

U. Calif., Davis, Calif.

Smith, E. R., Jr. MAINTAINING VEGETATION ON A BULLDOZED RIGHT-OF-WAY. J. Soil and Water Conserv. 16: 287-288. 1961.

Bulldozing as it is commonly practiced opens up rights-of-way to accelerated erosion, destroys wildlife food and cover, and encourages the establishment of fast growing trees; but by modifying this practice its undesirable effects can be greatly reduced. Newly developed clearing blades and root rakes do not disturb the topsoil as much, yet they effectively remove trees and brush. Establishing perennial shade tolerant plants such as sericea or shrub lespedeza and fescue will help prevent the re-entry of tree species on the right-of-way. Root sprouts or seedlings that do manage to get through this plant cover can be eliminated by an occasional mowing.

So that the right-of-way is most accessible to the utility company and is of greatest benefit to wildlife, the lowest growing vegetation should be planted in the center and the taller growing species established next to the woodland.

Arner (1951) stated that 3 years after planting, the cover on a bulldozed right-of-way in Maryland was only 9 percent woody plants. The cost of bulldozing and seeding this area was \$45.59 per acre; bulldozing cost \$40.00 and seeding \$5.59.

Gas companies with buried pipelines enjoy a definite advantage in planting their rights-of-way. Not only is the problem of erosion solved, but gas leaks can readily be detected through the distinct color change in the vegetation above the leak.

It would be worthwhile for utility companies to test these planting techniques and observe the advantages: The longer maintenance-free periods, the prevention of erosion through soil stabilization, the improved wildlife carrying capacity of the areas, the economies of operation effected, and the improved public relations.

SCS, USDA, Raleigh, N.C.

Warvel, H. FACTS ABOUT WINTER FEEDING. The Tenn. Conserv. 27(11): 6-7, 16. 1961.

Winter feeding is very controversial, being quite popular with the public which thinks it is doing the wildlife a favor, but considered by most professionals as an unsound management technique, especially when applied on a large scale. The professional feels that there is no substitute for natural food when it is available and that this should be the basis of good management.

There is no final answer that applies in all cases. Before venturing into a costly, time-consuming program where failure is likely to be the end result, we should stop and think. Some feeding on strictly an emergency basis has merit; however, the determination of an emergency should not be prematurely made. The covey of quail or the songbirds in the backyard can be helped when they can't find food, but to put out feed in an extensive haphazard manner during critical periods in the hopes that some needy animals will benefit or that the hunting population next year will be greater because of it, appears to be sheer nonsense.

Tenn. Game & Fish Comn., Nashville, Tenn.

Giles, R. H., Jr. A MAJOR GAME MANAGEMENT PRINCIPLE--THE BIG EDGE. Va. Wildlife 22(8): 10-11. 1961.

Contour farming and strip cropping produce many more cover types and borders that benefit most farm game than did the old block-farming methods. Planting large fields to a single crop provided little variety for wildlife and did not tend to build soil fertility, an essential for good wildlife as well as crop production.

To combine wildlife production with agricultural production does not necessarily require a change in acreage, but changes in edges. People interested in increasing wildlife numbers must be concerned constantly with the arrangement of things. To obtain optimum interspersion, land must be broken up into small units and mixed together. Utilization of rock outcrops, ditches and ditch edges, gullies and eroded spots, ponds, roadsides, and old wood roads can be effective application of edge effect for wildlife. The common wire fence which wastes a minimum of one acre of land for every two miles of fence can, under proper management, provide the edge essential for wildlife production.

Where field edges join forests there is unlimited opportunity for wise, multiple-use treatment of a small land area. Improvement of the edge can be made by establishing a border of recommended plants valuable to wildlife. A natural border can be made by clearcutting the woods around the field in a strip as wide as one-half the height of the average-size trees. Maintaining these two practices establishes a turn row for equipment, converts an area of poor crop production, builds and holds soil, provides additional edge depth for wildlife, and eliminates competition between forest and crops for nutrients, light, moisture, and space.

A clearcut strip should be maintained in vegetation gradually grading in size from grasses near the field to polesize trees near the forest. Such a diagonal canopy of leaves can be kept by mowing, brush cutting, pruning and use of herbicides. Planted edges also require occasional applications of fertilizer, seasonal mowing, reseeding, and even reworking the soil.

Ohio Coop. Wildlife Res. Unit, Ohio State U., Wooster, Ohio.

Davidson, V. E. FOOD COMPETITION BETWEEN GAME AND NON-GAME BIRDS. 26th N. Amer. Wildlife and Natural Resources Conf. Trans. pp. 239-245. 1961.

Choice foods can be provided for game birds, but competition from non-game species that gather in large flocks is a serious problem in the Southeastern States in fall and winter. Fifteen species of flocking birds are significantly destructive of game-bird foods.

Forty-six game-bird foods are discussed with emphasis on their suitability for management. The problem of their deterioration by rot, mold, and sprouting is discussed as a second limiting factor.

The foods to favor for bobwhites, mourning doves, wild ducks, and turkeys are suggested.

The problem of feeding game bird species better, in spite of flocking non-game birds and weather deterioration, is not insurmountable, however. It simply needs careful attention.

SCS, USDA, Athens, Ga.

Fay, L. D. THE CURRENT STATUS OF BRUCELLOSIS IN WHITE-TAILED AND MULE DEER IN THE UNITED STATES. 26th N. Amer. Wildlife and Natural Resources Conf. Trans. pp. 203-210. 1961.

Brucellosis is a comparatively rare disease in deer of the United States, and it is an unimportant disease from the standpoint of the health of the deer or deer as a reservoir of infection to livestock.

Nearly 17,000 white-tailed and mule deer in the United States have been tested for brucellosis. Of these, only 20 white-tailed deer were considered infected. The percentage of reactors among white-tailed deer in individual states ranged from none in 14 states to approximately 0.6 percent in two states. The highest incidence of reactors occurs in states that have been less active in the brucellosis eradication program in cattle.

Mich. Dept. Conserv., Lansing, Mich.

Gwynn, J. V. DEER CROP DAMAGE CONTROL. Va. Wildlife 22(10): 20-21. 1961.

Virginia's deer populations have been increasing since World War II. The preference by deer for certain garden, farm, and woodland crops has reduced many a landowner's income by various amounts depending on the number of deer in an area and the proximity of the crop to good deer cover.

Efforts to control deer crop damage have centered around (1) Frightening devices; (2) repellents; (3) shooting permits; and (4) fences. Except for the deer-proof fence, these methods of damage control work best where there are moderate numbers of deer and a brief period when damage is done. As deer populations increase, the period when damage occurs lengthens and the results of damage control methods become less satisfactory.

Different frightening devices and repellents are described and the address where they can be obtained is given.

The cost of an adequate woven wire deer proof fence was estimated at \$5.00 per rod installed.

Game Res. Biologist, Charlottesville, Va.

### Wetland Wildlife

Beshears, W. W., Jr. WATERFOWL MANAGEMENT ON THE FARM. Ala. Conserv. 32(4): 18-20. 1961.

Water areas, where food and cover conditions are attractive, should be provided to stop and hold more migratory waterfowl in Alabama during the winter season.

There must be plenty of favorable food. There must be cover, or a place for waterfowl to hide from enemies and to take refuge from heavy hunting.

Above all these birds must have water--plenty of shallow water--at all times, whether they are feeding, resting, roosting, or just loafing and playing.

Two primary requirements of an area for successful waterfowl management are (1) A dependable and controllable water supply; and (2) the right kind and amount of food and cover.

To develop an area for waterfowl, determine if you have, or can create, sufficient water for flooding grain crops or natural foods in late October or early November.

There are more than 20,000 farm ponds in Alabama. Most of these afford little more than resting water for wild ducks for a few hours at a time. Some have considerable shallow water, good cover, ragged shorelines, and perhaps some brush in the upper ends. These can be more attractive to waterfowl with little sacrifice of these primary uses. In general, the pond should be at least 5 acres or larger with drain pipe and valve to control water levels. There should be sufficient open area less than 3 feet deep in the upper end and edges of the pond for food plantings in the ratio of at least one acre of shallows to 5 acres of pond surface area.

The pond water level should be drawn about 3 feet the latter part of July or first of August and the exposed, shallow area planted to Japanese millet, or buckwheat. These crops are quick to mature and the late summer drawdown is less detrimental to fishing. After maturity, the standing grain should be flooded in late October or early November.

There are many farms in Alabama with large, lowland areas that could be developed for waterfowl. In general, such farm fields should be flooded to a depth of from 1 to 18 inches. Dabbling ducks such as mallards, blackducks, and wood ducks prefer food in shallow areas. They like to tip over to feed with only their feathery tails pointing out of the water. Field ponds should be drained in early spring. When dry, grain crops such as corn, sorghum, and millets should be planted. The area should be flooded again in late October or early November after the grains have matured.

One of the greatest possibilities for private waterfowl development is the artificial flooding of hardwood timber where acorn mast can be utilized as food for ducks. There are thousands of acres of land of this type located along streams and swamp areas throughout the state. Such areas could be artificially flooded by the construction of contour terraces, or low earthen dams, to impound large acreages of shallow water from 1 to 18 inches deep.

Bottomland flooding to create seasonal duck ponds offer many advantages, chief of which is low cost levee construction. Only low dams are needed, and can be built with bulldozer or farm tractor equipment. They can be designed by the landowner without engineering assistance, need no expensive maintenance, and can be broken for draining or plugged for flooding within thirty minutes if a drainpipe is not installed.

They can be built on timber land, but since pines would be subject to flood damage, it is suggested they be removed before flooding. Bottomland hardwood timber, however, suffers no ill effects from standing shallow water during winter months provided water is drained completely by March 1, or before the growing season starts. In fact, winter flooding of hardwood timber probably raises the water table, which in turn, results in increased tree growth and mast production.

Aquatic plants such as wildrice, wildcelery, duck potato, etc., are not recommended in Alabama.

(No address given.)

McDermott, R. E., and Minckler, L. S. SHOOTING AREA MANAGEMENT OF PIN OAK.

26th N. Amer. Wildlife and Natural Resources Conf. Trans. pp. 111-120. 1961.

In the central Mississippi Flyway, one of the important considerations for provision of duck food and cover is the characteristics of pin oak (Quercus palustris Muenchh.). This species occurs in essentially pure, even-aged stands on poorly drained sites.

With the establishment of public shooting areas in dense pin oak stands, successful area management hinges in part on three basic questions--(1) Can pin oak stands survive flooded conditions? (2) How does flooding affect mast production in terms of quality and quantity in various stand conditions? And (3) can pin oak be regenerated under flooded conditions and subsequent heavy use by ducks?

During the past 4 years, stand and mast characteristics of pin oak stands 25-35 years old have been analyzed at the Duck Creek Wildlife Area and the Mingo National Wildlife Refuge in southeastern Missouri.

Four years after the beginning of fall-winter flooding, there are strong indications that wildlife management objectives and timber management objectives are compatible. Pin oak trees do survive under the conditions of fall and winter flooding that are necessary for shooting area development. Stands on the flooded area had greater amounts of sound acorn mast and there was less insect infestation. Pin oak regeneration is greatly reduced by flooding probably because of consumption of the sound acorns by ducks, and flooding may have to be discontinued for one to three years at the time of stand regeneration.

Reduced basal areas of pin oak stands is an acceptable management practice because within two to three years thinned stands produced nearly as much mast as the unthinned stands. Such practices may create a more favorable habitat for ducks and the timber values may be improved with further cultural operations.

Dept. Forest Mangt., Pa. State U., University Park, Pa.

Robel, R. J. THE EFFECTS OF CARP POPULATIONS ON THE PRODUCTION OF WATERFOWL FOOD PLANTS ON A WESTERN WATERFOWL MARSH. 26th N. Amer. Wildlife and Natural Resources Conf. Trans. pp. 147-159. 1961.

The relationship between carp and waterfowl food plant productivity has been studied since 1959. The marsh of the Bear River Club Company in northern Utah was the study site. The extent and manner in which carp affected submersed aquatic plants were investigated.

Three stratifications of carp populations of approximately 200, 400, and 600 pounds per acre equivalent were confined to enclosures constructed of welded-wire fencing.

Turbidity measurements were made throughout the summers. Vegetation surveys were conducted at the beginning and end of each summer period.

Data indicated no relationship existed between carp stocking rates and water turbidity. A close negative correlation existed between the amount of vegetation present and the carp population levels. No significant reductions in vegetation productivity were noted when carp populations were below 200 pounds per acre. Carp population concentrations in excess of 200 pounds per acre greatly reduced the amount of vegetation present.

Utah Coop. Wildlife Res. Unit, Utah State U., Logan, Utah.

Ryder, R. A. COOT AND DUCK PRODUCTIVITY IN NORTHERN UTAH. 26th N. Amer. Wildlife and Natural Resources Conf. Trans. pp. 134-147. 1961.

On and around Ogden Bay Refuge, Utah, quantitative data regarding the effects of coots upon the production of ducks was obtained for two years. Emphasis was placed upon comparative breeding behavior, nesting, and young-rearing success.

Observations were limited mainly to five study areas. Coots were reduced by killing adults and destroying nests on two areas, while unsuccessful attempts were made to increase coots on one area by introducing wild birds. Two areas were left untreated as controls.

On the study areas, the total breeding pairs of coots exceeded those of ducks, but the ratio of coot pairs per 100 duck pairs varied from 67 to 225 on the various areas. In addition to coots, seven species of dabblers and two species of diving ducks nested on the study areas.

Coot nesting densities were greatest on areas with considerable open water in proportion to available nesting cover. Duck nesting densities, in contrast, seemed somewhat greater on areas with a higher proportion of cover.

Coots had considerably better nesting success than ducks probably due to the following factors: (1) Coots seemed less likely to desert than ducks; (2) coots nested more over water and were less subject to mammalian predation; and (3) both coots of a pair shared in incubation and actively defended the nest. Coots were also persistent renesters and approximately 13 percent of the coot pairs on the untreated areas hatched second broods.

Juvenile coots seemed to suffer higher mortality the first few weeks of their lives than ducklings. Because of their better nesting success, coots still fledged more young per pair than ducks.

On a unit-area basis, many more coots than ducks were produced on the untreated areas. Based on nest observations, duck production per 100 acres of cover was not appreciably greater on treated areas (coots reduced) than on untreated areas. There was greater use by duck broods of the area on which coot hatching was reduced by nest destruction.

Possible management implications include: (1) Continued cattail control; (2) construction of more small ditches through saltgrass flats; (3) increased predator control; and (4) continued educational campaigns to obtain greater hunter utilization of coots.

Colo. State U., Fort Collins, Colo.

Craighead, J. J., and Stockstad, D. S. EVALUATING THE USE OF AERIAL NESTING PLATFORMS BY CANADA GEESE. *J. Wildlife Mangt.* 25: 363-372. 1961.

During a 5-year period, 73 aerial platforms, on an average, were available each year to Canada geese. One-hundred and seven aerial nests of all types were observed; 49 of these were located in the aerial platforms and 58 in natural elevated sites. Since there was no decrease in the use of natural aerial structures during this time but a decrease in ground nests did occur, it was concluded that the platforms caused a greater number of geese to select aerial sites. The percentage of all nesting geese in the population that used nesting platforms increased progressively from 1 percent in 1954, when platforms were first erected, to 9 percent in 1958. The use of all elevated nest sites, including platforms and natural structures, increased from 5 percent in 1953 to 18 percent in 1958.

There was no evidence that the nesting platforms increased the number of geese nesting in the study area. Platforms caused significantly measurable effects in nest-site selection, mortality factors, and hatching success. Use of platforms caused a decrease in island ground nests and an increase in island aerial nests.

A general decrease in island nesting and a corresponding increase in use of lake and river shore lines, though not statistically significant, showed a trend and is believed to be due to use of platforms. Supporting this belief is the fact that 41 percent of all platforms erected along shore lines were used as nesting sites. Geese using aerial platforms showed a slight increase in reproductive rate, significantly better hatching success, and a higher percentage of nests successful. The platforms significantly increased desertion as a cause of nest failure, but significantly reduced predation. This was not compensatory as there was a net gain in goslings hatched. Gosling mortality incurred while getting out of elevated nests was negligible. It is concluded that construction of aerial platforms benefited the geese, but to be most effective, platforms should be rehabilitated annually, erected 20 to 50 ft. above the ground, and located in situations remote from human activities.

U.S. Fish and Wildlife Serv., Missoula, Mont.

Stotts, V. D., and Davis, D. E. THE BLACK DUCK IN THE CHESAPEAKE BAY OF MARYLAND: BREEDING BEHAVIOR AND BIOLOGY. *Chesapeake Sci.* 1(3-4): 127-154. 1960.--(From *Wildlife Rev.* 103: 69. 1961)

The study was conducted from 1953-8 on the Eastern Shore of Chesapeake Bay. The following were noted: (1) The nesting peak occurred about 10 Apr.; (2) first hatching in early Apr.--the last in early Aug.; (3) nests were built most extensively in woods, less so in fields and marshes, and markedly in duck blinds; (4) the nest density varied from 0.6 to 15.2 nests per acre; (5) the average number of eggs per clutch declined from 10.9 to 7.5 during the season; (6) young ♀ laid smaller clutches than adult ♀; (7) average incubation period was 26.2 days; (8) it was estimated that 100 ♀ would produce 510 young to flying age; and (9) population in the area would decline if the mortality rate of ♀ from flying age to breeding exceeded 78%.

Md. Game and Inland Fish Comm., Annapolis, Md.

## SUPPLEMENT

### Radioactive Fallout

Menzel, R. G., Myhre, D. T., and Roberts, H., Jr. FOLIAR RETENTION OF STRONTIUM-90 BY WHEAT. *Sci.* 134 (3478): 559-560. Aug. 25, 1961.

Wheat harvested from the University of Maryland Agronomy Farm in June 1959 contained 20 to 50 micro-microcuries of strontium-90 per kilogram of grain. More than 90 percent of the strontium-90 came from deposition on aboveground plant parts, and less than 10 percent was taken up through the soil. About 1 to 2 percent of the strontium-90 fallout during the time the heads were exposed was retained in the grain.

SWCRD, ARS, USDA, Beltsville, Md.

Schulz, R. K., and Riedel, H. H. EFFECT OF AGING ON FIXATION OF STRONTIUM-90 BY SOILS. *Soil Sci.* 91: 262-264. 1961.

In order to investigate the possibility that carrier-free Sr-90 may become fixed by soils in a nonexchangeable form with the passage of time, three soils were analyzed for nonexchangeable Sr-90 shortly after addition of the isotope and after aging periods of 2.5 or 3.5 years.

Three soils were studied: Hanford vfls1, Yorkville 1, and Columbia vfls1.

With the passage of several years a small fixation of Sr-90 was found to exist in a nonexchangeable form in soils. This fixation probably takes place, in part, by incorporation in  $\text{CaCO}_3$  crystals when soils contain this material. In all soils studied, fixation appears to be caused by entry of the Sr-90 into such solid phases as strontium or calcium phosphates or other crystals containing strontium or calcium.

U. Calif., Berkeley, Calif.

Romney, E. M., Alexander, G. V., Nishita, H., and Larson, K. H. INFLUENCE OF CA AND SR AMENDMENTS ON SR<sup>90</sup> UPTAKE BY LADINO CLOVER UPON PROLONGED CROPPING. *Soil Sci. Soc. Amer. Proc.* 25: 299-301. 1961.

Prolonged cropping experiments showed that a single application of CaCO<sub>3</sub> in the amount recommended to produce better crop growth (2 to 5 tons an acre) continued to suppress Sr-90 uptake from an acidic soil that initially was deficient in plant-available Ca. This effect of treatment is attributable to the complementary ion influence of Ca on Sr. The cumulative amount of Sr-90 removed by 15 successive cuttings of ladino clover was 29.38, 15.71 and 11.61% of the dose from Sassafras sl treated with CaCO<sub>3</sub> at levels of 1, 5 and 10 me, Ca per 100 g. soil (equivalent to 0.5, 2.5 and 10 tons CaCO<sub>3</sub> an acre respectively). The greatest amount of the Sr-90 dose removed from the soil by a single clover cutting was 6.38% at the 1 me. Ca treatment.

A single application of Sr(NO<sub>3</sub>)<sub>2</sub> amendment at levels of 0.05, 1 and 2 me. Sr per 100 g. soil (equivalent to 0.05, 1 and 2 tons Sr(NO<sub>3</sub>)<sub>2</sub> an acre) initially increased plant uptake of Sr-90 from Hanford sl as a result of the displacement of Sr-90 from the exchange complex by stable Sr into the soil solution where it was more readily available to the plant. This enhancing effect of low levels of Sr amendment on Sr-90 uptake became less apparent as time progressed. The carrier-dilution effect of reducing plant uptake of Sr-90 from Hanford sl was achieved by applying Sr(NO<sub>3</sub>)<sub>2</sub> at a level of 10 me. Sr per 100 g. soil (equivalent to 10 tons Sr(NO<sub>3</sub>)<sub>2</sub> an acre).

Sch. Medicine, U. Calif. Los Angeles, Calif.

Mortensen, J. L. RADIOACTIVE FALLOUT. *Agron. J.* 53: 343-348. 1961.

Fallout can be divided into three somewhat arbitrary categories: local, tropospheric, and stratospheric. The local fallout consists of the larger particles in the bomb debris and is deposited downwind within 18 to 24 hours after detonation. Local fallout is particularly heavy following the surface detonation of a larger nuclear device. The distribution of local fallout from nuclear detonations is dependent upon meteorological conditions, and debris may be carried several hundred miles downwind.

Larger particles fall out nearest ground zero. Fallout particles less than 44 microns in diameter are biologically more significant because of their relatively high solubility and high degree of retention on the foliage of forage crops. Externally contaminated cover crops and dry organic materials incorporated into soils are sources of radioisotopes for subsequent crops grown on these soils.

The gamma radiation decay rate of local fallout is approximated by T<sup>-1.2</sup> (T is time after detonation) up to several months after the detonation. Seventy percent of the fission products are short-lived and the radiation decreases by 1/3 the first 7 hours and another 1/3 in 7 days.

The tropospheric fallout is carried rapidly around the world on prevailing west-east winds. This material is washed down in several weeks by rain and snow in about the same latitude as the point of detonation. "Hot spots" of fallout deposition occur when heavy precipitation washes debris out of the radioactive cloud as it is carried by winds across the country.

The uptake of fission products by plants depends on their chemical properties as well as the chemical and physical properties of the soil. The relative order of magnitude of uptake of fission products and plutonium-239 by plants from contaminated soils has been shown to be Sr<sup>89</sup>-Sr<sup>90</sup>>>I<sup>139</sup>>Ba<sup>140</sup>>Cs<sup>137</sup>, Ru<sup>106</sup>>Ce<sup>144</sup>, Y<sup>91</sup>, Pm<sup>147</sup>, Zr<sup>95</sup>-Nb<sup>95</sup>>Pu<sup>239</sup>. The uptake of Cs<sup>137</sup> is usually one-tenth to one-fiftieth that of Sr<sup>90</sup> but Cs has greater

mobility within plants. The greatest concentration of fission products resulting from soil uptake is usually found in the leaves of plants. Potential hazards in the food chain are thus reduced since other parts of most plants are most commonly used for food. Uptake and distribution of fission products in different plant parts may be altered by nitrogen, potassium, and phosphorus fertilization.

The rooting habit and nutrient requirements of plants also affect uptake of fission products. Plants with shallow root systems usually absorb more fission products than deeply rooted plants, since most of the fission products are yet near the soil surface. When Sr<sup>90</sup> is uniformly distributed in the soil, legumes take up from 3 to 6 times as much Sr<sup>90</sup> as do many of the grasses.

Ohio State U., Ohio Agr. Expt. Sta., Wooster, Ohio.

Menzel, R. G., and James, P. E. REMOVAL OF RADIOACTIVE FALLOUT FROM FARM LAND: PROGRESS REPORT NUMBER I. Agr. Engin. 42: 606-607. 1961.

In 1958, two experiments on the physical removal of radioactive surface contamination were conducted at the USDA Agricultural Research Center at Beltsville, Md. In the first experiment, contaminated sod, standing crops, and straw mulches were removed. The standing crops were Sudan grass and soybeans about 12 in. tall. In the second experiment, contaminated surface soil was removed from fields of Elkton sil and Sassafras sl. The surface soil was removed with a road grader. Prior to contamination, different plots of soil were prepared as plowed land, disked land, and seedbed. After contamination, rolling and applications of asphalt were tested to see whether or not they would improve the removal of contamination with the road grader.

The percentages of decontamination achieved by removal of crops and mulches are given in Table 1. Decontamination by removal of surface mulches was quite effective. Removal of sod was quite effective. Removal of standing crops was rather ineffective. An attempt was made to pick up a thin layer of surface soil with the flail chopper. This proved to be very difficult as the fan quickly clogged. The rapidly moving flails also caused a great deal of radioactive dust.

Table 1.--Percentage of decontamination by removal of crops and mulches

Treatment	Percentage Ba-140 removed
Raking mulch, 10 T/A .....	100
Raking mulch, 5 T/A.....	97
Raking mulch, 2 T/A.....	94
Cutting and removing sod.....	94
Flail chopping soybeans and some soil, after mowing.....	89
Flail chopping Sudan grass and some soil, after mowing.....	60
Mowing soybeans.....	37
Mowing Sudan grass.....	29

The average percentages of decontamination achieved by scraping bare soil ranged from 60 to 100 (Table 2). Soil prepared as a seedbed was usually more effectively decontaminated than the rougher soil surfaces, but this difference reached the 70 percent level of statistical significance on Elkton sil only. Rollers were used to smooth the rougher surfaces after contamination and before scraping. The sidewalk roller used on Sassafras sl was

unsatisfactory because it tipped easily, placing radioactivity at uneven depths. Decontamination was significantly poorer following its use. The corrugated roller used on Elkton soil improved decontamination.

Some of the plots were sprayed with asphalt-water emulsion at the rate of one gallon per square yard. The asphalt broke in scraping and had little effect on the removal of contamination.

Table 2.--Percentage of decontamination by scraping surface soil following various treatments

Number of cuts with grader	Asphalt spray	Soil preparation					
		Plowed		Disked		Seedbed	
		Rolled	Not rolled	Rolled	Not rolled	Rolled	Not rolled
Sassafras sandy loam							
1	Yes	75	96	66	70	82	99
1	No	85	68	60	80	62	100
2	No	89	100	95	100	93	100
Elkton silt loam							
1	Yes	91	69	88	89	99	92
1	No	98	84	91	91	94	96
2	No	87	91	100	86	100	100

SWCRD, ARS, USDA, Beltsville, Md.

Menzel, R. G., Roberts, H., Jr., and James, P. E. REMOVAL OF RADIOACTIVE FALLOUT FROM FARM LAND: PROGRESS REPORT NUMBER II. Agr. Engin. 42: 698-699. 1961.

An earlier report (Agr Engin. 42: 606-607. 1961.) described experiments in which agricultural land was decontaminated by removing standing crops, sod, straw mulch, or surface soil. These experiments were continued in 1959 and 1960 with modifications designed to stimulate more closely the expected conditions in case of fallout contamination from nuclear explosions.

The scrapers gave 60 to 100 percent decontamination, with over 90 percent decontamination achieved in one-half of the trials. Irrigation had no apparent effect on decontamination by scraping. Generally, no significant differences in decontamination have been found between different types of scrapers. Care must be taken to operate it at a uniform depth sufficient to remove surface depressions.

About 1 month before the plots were contaminated, a mulch of Bermuda grass hay was applied at rates of 2 to 5 tons per acre. Several rains had pressed the mulch into close contact with the soil surface. After the contamination and irrigation treatments, the mulch was raked into a windrow and picked up with a baler. About 30 percent of the fallout was removed with 2 tons of mulch per acre and about 60 percent with 5 tons of mulch per acre.

The contamination and irrigation treatments were applied on a full-grown rye crop. The crop was removed by three methods with less than 30 percent decontamination achieved by any method. Comparable results were reported earlier for crop removal. A lower percentage of decontamination was achieved after simulated rainfall.

Table.--Decontamination by removing rye crop with various implements as affected by irrigation, June 1960\*

Implements	Decontamination +	
	Not irrigated, percent	Irrigated, percent
Direct cut forage harvester.....	30	18
Mower, rake, and baler.....	24	18
Combine harvester-thresher .....	22‡	11‡

\* The weight of fallout was 0.3 lb. per 48 sq. ft.

+ Decontamination is averaged from results on Sassafras sandy loam and Elkton silt loam, except for the combine harvester-thresher, which was used only on Sassafras sandy loam.

‡ Three-quarters of an inch of rain fell before decontamination.

Where a high percentage of fallout removal is required, soil scraping appears to be the best of the methods employed in this study. Crops removal would only be useful in areas of low contamination or as a preparatory step to other methods of decontamination.

SWCRD, ARS, USDA, Beltsville, Md.

